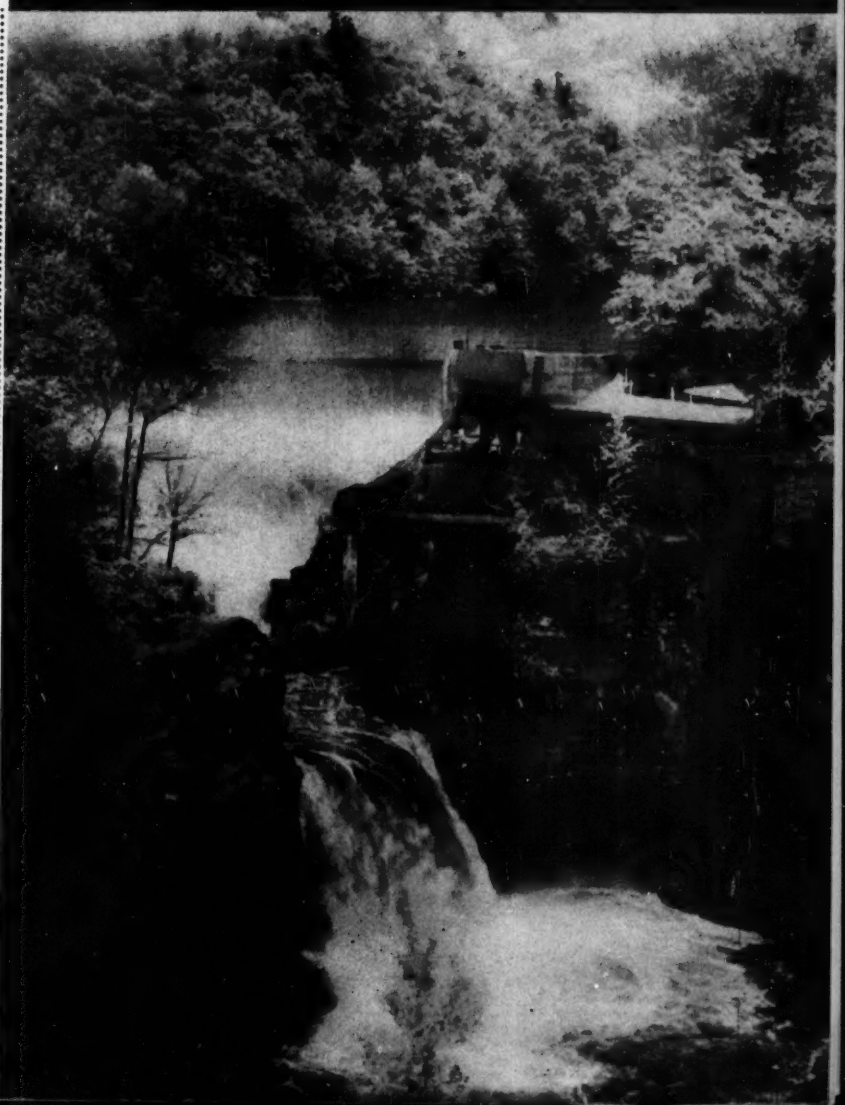
COLLEGE OF ENG

the Cornell

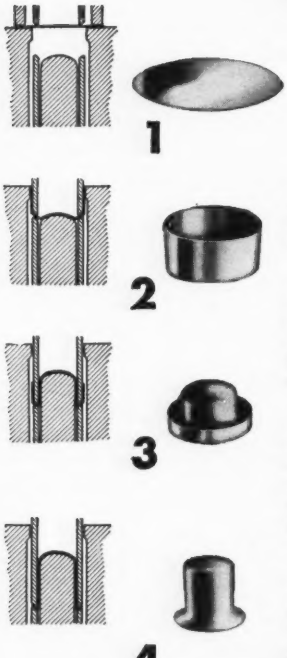


MARCH, 1953

VOL. 18, NO. 6

25 CENTS

How to turn a high strength steel cup inside out, cold



OFFHAND, anyone familiar with high strength steels would say it couldn't be done. But one of our customers does it every day.

Employing a unique reverse-drawing method and using a U·S·S High Strength Steel especially adapted for this process, they turn out cylindrical containers of various kinds that are not only stronger than those made from carbon steel but weigh substantially less.

To accomplish this, the steel has to meet two entirely opposite requirements. It has to be so strong that it can be used in thinner gages to reduce weight, and yet must have enough ductility to satisfy the drastic fabrication method that would be considered severe even for carbon steel.

This method is used to draw cups for large, low-pressure cylinders. These cups, 14½ in. in diameter and 24½ in. deep, are drawn cold, from 12-gage steel blanks in one continuous stroke in a reverse draw press. The diagrams at left show how it is done.

Starting with a 38 in. diameter steel blank (Fig. 1) the press first draws the steel into a shallow cup (Fig. 2). As the stroke continues, the cup is literally *turned inside out* (Fig. 3) to form the finished cup (Fig. 4) which has very uniform wall thickness. Two of these cups are then welded together to make a cylinder.

Made with high strength steel, cylinders weigh about 20 lbs. less. The maker gets 26% more cylinders from each ton of steel used. Lighter weight makes cylinders easier to handle, and also pays off in lower freight costs—both on the steel from our mills and on cylinders shipped. (A customer 500 miles away saves as much as $100 per carload.)

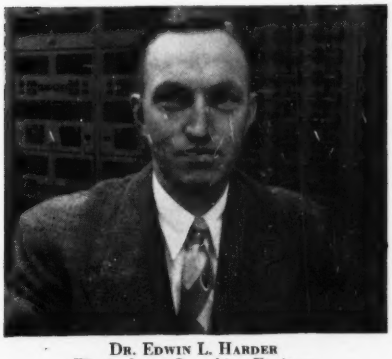
Developing special steels for special customer needs is an important job of United States Steel metallurgists and engineers. With their tremendous background of practical experience, they are ready to work on any problem that involves the more efficient use of steel. United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

USS

UNITED STATES STEEL

DR. CLINTON R. HANNA, *Associate Director*
Westinghouse Research Laboratories
Enrolled in Westinghouse Graduate Student Training Course after graduation from Purdue University in 1922. Dr. Hanna, with over 100 patents to his credit, is one of the nation's leading authorities on gyroscopically controlled regulating devices.

CARROLL V. ROSEBERRY, *Manager*
Westinghouse Electric Utility Department
Upon graduation from Oklahoma A & M in 1934, he enrolled in the Westinghouse Graduate Student Training Program. Assigned first as a salesman, he was advanced to district Assistant Electric Utility Manager, branch Electric Utility Supervisor, and in 1951 was appointed to his present post.



DR. EDWIN L. HARDER
Westinghouse Consulting Engineer
Enrolled in Westinghouse Graduate Student Training Course after graduation from Cornell University in 1926. Dr. Harder has become nationally known for his analytical and development work in power systems. He is co-developer of the Anacom, an electric analogue computer.

They did what you can do to achieve success

These Westinghouse executives have several things in common . . . a desire to excel, intense enjoyment of their work, and early training in their fields of specialization. All entered Westinghouse through the Graduate Student Training Program . . . the same program that today is launching young engineers on careers with Westinghouse.

You can do what these men did to achieve success. They found out early what their likings and talents were, what they wanted to do, and set their sights accordingly. With the help of the Westinghouse Training Program, you, too, can get off to a sure start on the career of your choice.

The Westinghouse Graduate Student Training Program

This program has been carefully developed through 50 years to enable top men, selected in leading colleges, to choose their careers wisely from the wide variety of opportunities available at Westinghouse. The program gives you a clear understanding of the company and its products . . . lets you try out many types of work through planned work assignments . . . and offers you the benefit of personal counsel in selecting the field for your career. The Westinghouse Graduate Student Training Program helps supply the answer to that all-important question, "Which is the *right* career for you?"

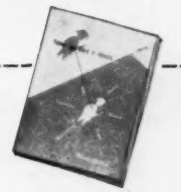
For full information on the Westinghouse Training Program, send for our 32-page book, "Finding Your Place in Industry."

G-10250

EDUCATIONAL DEPARTMENT

YOU CAN BE SURE...IF IT'S

Westinghouse



To obtain copy of "Finding Your Place in Industry", consult Placement Officer of your university, or mail this coupon to:

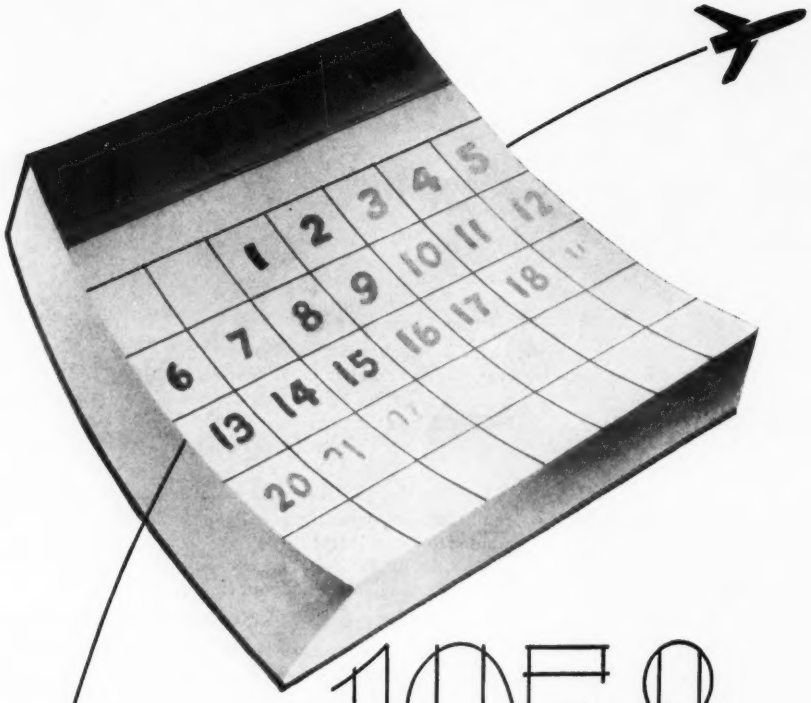
Mr. C. S. Purnell
District Educational Co-ordinator
Westinghouse Electric Corporation
40 Wall Street
New York 5, New York

Name_____

School_____ Year_____

Street_____

City_____ Zone_____ State_____



it's 1958 today!

...in jet engine design

As far as our engineers are concerned 1953 started 5 years ago. Today they are designing and developing dependable engines for the aircraft of 1958 or later. They are working on more powerful jet engines . . . even on a nuclear engine.

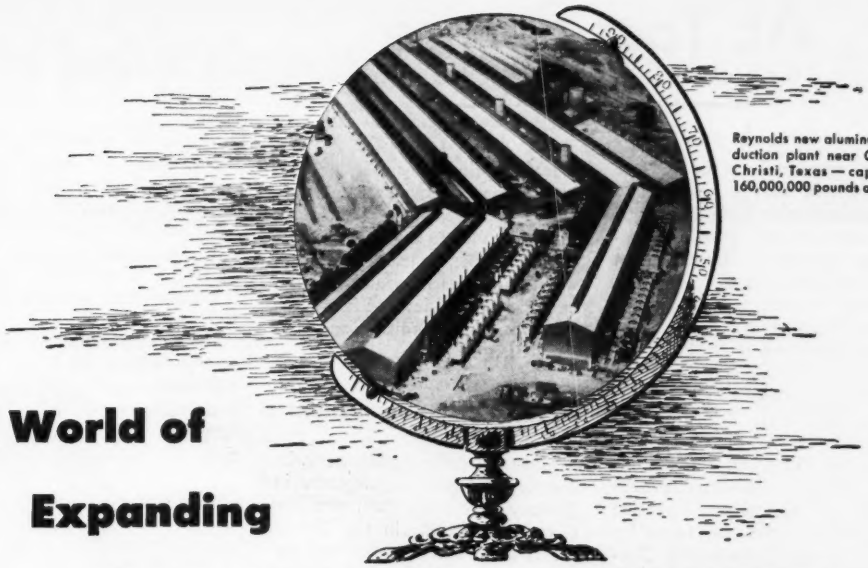
This kind of engineering in advance of the calendar has made Pratt & Whitney Aircraft the world leader in flying engines.

If you would like to work for the company with a future . . . serving an industry with an unlimited future . . . set your sights on Pratt & Whitney Aircraft.

MORE AIRCRAFT ENGINES
BEAR THIS EMBLEM
THAN ANY OTHER.

Pratt & Whitney Aircraft
DIVISION OF UNITED AIRCRAFT CORPORATION

EAST HARTFORD 8, CONNECTICUT U.S.A.



Reynolds new aluminum reduction plant near Corpus Christi, Texas — capacity 160,000,000 pounds a year.

A World of Expanding Opportunity!

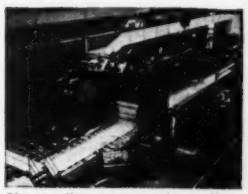
In a land noted for rapid expansion of free industrial enterprise, few companies have matched the swift and continuing growth of the Reynolds Metals Company. Now operating 27 plants in 13 states, and still expanding, Reynolds offers the ambitious engineering graduate a world of opportunity.

Reynolds operations include bauxite mining in domestic and foreign locations...chemical and electrolytic processing to produce aluminum pig ...sheet rolling...drawing and extrusion of mill and structural shapes ...foil rolling and printing...powder and paste production...finished parts and products fabrication. In these and in the allied sales and marketing operations promising careers exist for graduates in virtually any phase of engineering.

On-the-job training is the Reynolds policy—after preliminary orientation which may include basic experience in production plants for sales personnel, and sales office work for technical trainees. Liberal insurance, hospitalization and retirement programs are maintained.

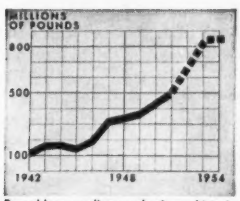
For important background information on "your future in Aluminum," *mail the coupon.* If you are definitely interested now, write direct to General Employment Manager, Reynolds Metals Company, 3rd and Grace Streets, Richmond 19, Va.

Tapping one of huge battery of electrolytic cells



Sheet rolling—reverse hot mill in operation

REYNOLDS ALUMINUM



Reynolds expanding production — historic chapter in 33 years of continuing growth.

Reynolds Metals Company, Employment Dept.
Richmond 19, Virginia

Please send me, **FREE**, your 96-page booklet, "The ABC's of Aluminum"; also the 44-page book, "Reynolds Aluminum . . . and the Company that makes it."

Name_____

Address_____

At Your Service

New opportunities for college graduates, or college seniors who will graduate this June, both men and women, to obtain direct commissions as second lieutenants in the United States Air Force Reserve and receive a full year of government-paid schooling in basic meteorology have been announced.

To receive their appointments, applicants must possess a bachelor's degree, and must have received credit for one year of college physics and mathematics through integral calculus. Interested college seniors and graduates will receive the required application forms by writing to the Commanding General, Air Weather Service, Washington 25, D. C.

College graduates selected for weather training will enter school either this June or in September and will receive full pay and allowances as second lieutenants during their tour as students. During their expense-paid schooling, USAF second lieutenants receive about $350 a month with dependents, or slightly less without dependents.

Following completion of training, the new weather officer will be assigned to a AWS weather station, and will brief pilots and navigators on weather conditions encountered in flight. Some weather officers will be selected to assist in Air Force and Army research projects, involving guided missiles, atomic development, and new types of aircraft.

After some field experience, weather officers may apply for additional government-paid schooling in advanced meteorology which, in many cases, will result in a master's degree in science.

Du Pont Teaching Grants

Renewal of Du Pont's grant of a fellowship in chemical engineering continues a program started by the company in 1918 to encourage students to undertake postgraduate work in chemistry, since expanded to include other fields of science and engineering. It provides support for pre-doctoral training of students and is intended to help maintain the flow of technically trained men and women into teaching and research work at universities and into technical positions in industry and government.

A. F. Reserve Commissions

Mid-term college graduates who completed degree requirements in January may apply for immediate direct commissions in the United States Air Force Reserve and assignment to basic meteorology graduate training in June. Qualified graduates, who must have received credit for one year of college physics and mathematics through integral calculus, will receive complete application forms by writing to the Commanding General, Air Weather Service, Washington 25, D. C. College seniors, both men and women, who will graduate in June with required physics and mathematics credits may also apply at this time for commissions to be awarded following graduation. June graduates will enter graduate meteorology school in September.

The June class, which will be of limited size, was established specifically to provide an early entrance into weather school for mid-term 1953 graduates. Since several weeks are required to process the application forms and obtain approval from the participating university, qualified graduates are being urged to submit application forms as soon as possible. Mid-term graduates who fail to submit their applications in time for the June class by March 1 will be considered for the September classes.

Participating colleges and universities offering the government-paid basic meteorology courses include the following schools: Massachusetts Institute of Technology, New York University, University of Chicago, Pennsylvania State College, University of California at Los Angeles, Florida State University, University of Washington, and St. Louis University. Only one of these will offer the special June class.

During the graduate training in either basic or, later, advanced meteorology, all tuition and other expenses are paid by the government and the student receives full pay and allowances in his current grade. For a second lieutenant who is married, this amounts to about $350 a month.

Following completion of the basic weather officer course, the officers will be initially assigned to officer basic military course and then to duty in an Air Force weather station.

Gas Sales Conference

This year's American Gas Association Sales Conference on Industrial and Commercial Gas will be held at the Hotel Warwick, Philadelphia, Pa., April 13, 14 and 15. The first day will be Commercial Gas Day, the second a General Session with dinner in the evening, and the third Industrial Gas Day.

Frank C. Smith, president of American Gas Association; Colonel Hudson W. Reed, president of the Philadelphia Gas Works Co.; and George E. Whitwell, vice president of Philadelphia Electric Co., have been invited to address the general session. There will be talks on "The Aims of Industrial and Commercial Gas Advertising and Publicity," "The Future of Industrial Gas," and "Commercial Gas Cooking Promotion."

McGraw-Hill Contest

Electrical Construction and Maintenance, McGraw-Hill publication, has announced a competition for the best lighting installation initiated and completed by an electrical contractor between Jan. 1, 1952, and Aug. 1, 1953, when the contest closes. Prizes totaling over $1,000 will be given to first, second and third place winners in each of six classifications.

The purpose of the contest is "to encourage, and to extend public in-

(*Continued on Page 6*)

What's Happening at CRUCIBLE

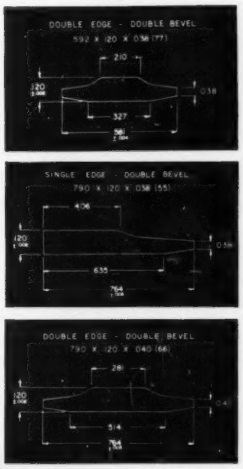
about clicker die steel .

what it is

Clicker die steel is a special cold rolled alloy steel. It is used in making clicker dies for cutting leather, rubber, plastic, felt and fabrics of other compositions that go into the making of shoes and similar products.

Finished clicker die ready for cutting shoe leather.

Some of the clicker die steel standard shapes.



Wider shapes are used when dies are sized by surface grinding after forming and welding. Standard widths are provided when the dies are not to be surface ground.

how it is used

Clicker die steel is furnished to the die maker in either single or double edged form in one of several standard shapes. The die maker first shapes the die by bending the die steel to a pattern that provides the desired configuration, and then welds the two ends at a corner. He finishes the die by grinding a bevel on the outside of the cutting edge and filing the inside edge. Before the finished die is hardened and tempered, the die maker forms identification marks – combinations of circles and squares – in the cutting edge so that the material cut from it may be easily identified as to its size and style.

In the cutting operation, the leather or other material is placed on an oak block in the bed of the clicker machine. Then the die is placed by hand on the material which is cut as the aluminum faced head of the machine presses the die through it. The clicking sound which the head makes as it strikes the die is where the term "clicker machine" derived its name.

what it is composed of

Clicker die steel as produced by the Crucible Steel Company of America is a controlled electric steel in which the combination of carbon and alloy is designed for maximum toughness and proper hardness after heat treatment.

Experience has proved that cold finished clicker die steel is superior to hot rolled material for sizes approximately ¾ inch and narrower because of its lower degree of surface decarburization which permits the use of slightly thinner sections. Cold finished material also has a better surface finish with closer width and thickness tolerances and thinner edges that require less grinding and filing to complete the die.

CRUCIBLE'S engineering service

As with clicker die steel, the Crucible Steel Company of America is the leading producer of special purpose steels. If you have a problem in specialty steels, our staff of field metallurgists with over 50 years experience in fine steel making is available to help you solve it. Crucible Steel Company of America, General Sales and Operating Offices, Oliver Building, Pittsburgh, Pa.

CRUCIBLE first name in special purpose steels

53 years of Fine steelmaking

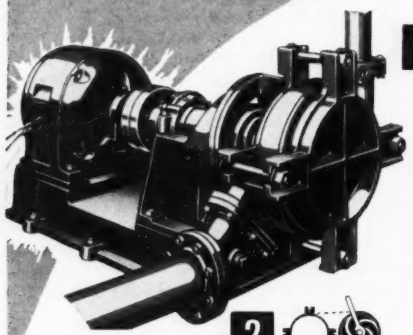
Midland Works, Midland, Pa. • Spaulding Works, Harrison, N. J. • Park Works, Pittsburgh, Pa. • Spring Works, Pittsburgh, Pa.
National Drawn Works, East Liverpool, Ohio • Sanderson-Halcomb Works, Syracuse, N. Y. • Trent Tube Company, East Troy, Wisconsin

Morris

Type R Slurry Pump

Gives Longer Service, Less Trouble

because



1

No internal studs or bolts — no troublesome internal joints and fits. Suction Disc Liner is merely *clamped* into position between disc and shell. Fewer wearing parts mean less maintenance and longer uninterrupted service.

2

Impeller and shaft sleeve of the Morris Type-R Slurry Pump can be renewed *without disturbing* the suction and discharge piping or the bearings. This means considerably less lay-up time.

3

Due to the clamping effect of the bolts on the discs, the shell is not subject to high stress. Consequently, the shell can be made of a wide variety of materials, including those of high abrasive resistance. Yet these materials need not necessarily be of high tensile strength.

4

Hydraulic passages of the suction discs are extremely large and velocities are low. As a result, wear is minimized and renewal infrequent.

5

Stuffing box troubles are practically eliminated because the suction gland is under low suction pressure only.

Write today for free bulletin

Practical information in Bulletin No. 181 shows by performance curves just how the Morris Type-R Slurry Pump fits specific operations . . . describes exclusive construction features that cut operating costs.

FOR CHEMICAL OPERATIONS

Morris Type-R Slurry Pump handles mixtures containing ore concentrates . . . tailings, slag and residue from filters and classifiers . . . all types of caustic or acid mixtures containing abrasives or solids.

MORRIS MACHINE WORKS

Baldwinsville, N. Y.

Branch Offices in Principal Cities

MORRIS *Centrifugal Pumps*

Service

(*Continued from Page 4*)

dustry recognition to electrical contractors and their employees who initiate, sell, and install outstanding lighting installations, and to further the dissemination of meritorious lighting information."

A contractor or full-time employee of a contractor can enter in the contest an installation of any size that covers one or more of the following: a lighting technique for a single visual requirement; a lighting installation for a specific area, large or small; an overall lighting installation for an entire building, or general area.

Entries will be judged by a board of five well-known authorities in the lighting industry, which will include Everett M. Strong, Cornell professor of electrical engineering.

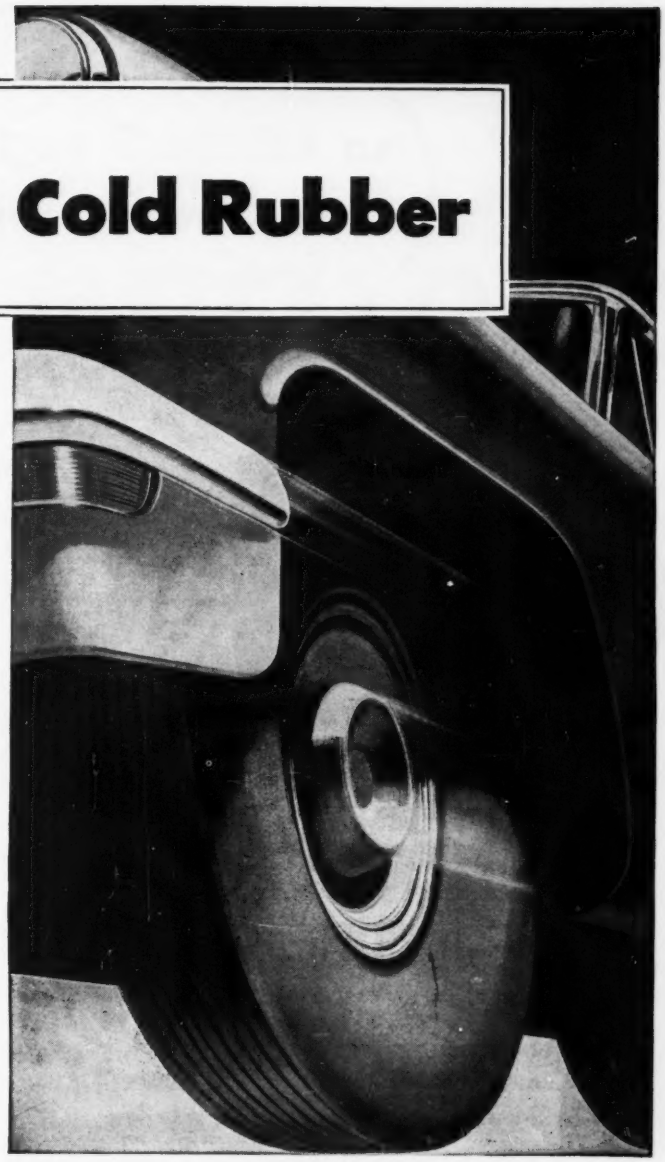
First prizes of $100, second prizes of $50 and third prizes of $25 will be awarded in each of the following classifications: stores, schools and offices, industrial, residential, floodlighting, and miscellaneous.

Wood Industry

The past century's development of wood from the status of a natural resource having broad utility value, yet with little known of its strength properties, into an engineering material with predetermined load-bearing capacities, is recounted by 26 of the nation's leading engineers, wood technologists, and scientists in the book, *Proceedings of Wood Symposium on One Hundred Years of Engineering Progress with Wood*, recently published by Timber Engineering Co., affiliate of National Lumber Manufacturers Association.

The book is a compilation of outstanding papers presented at the wood symposium held during the centennial of Engineering Convocation in Chicago last fall. Symposium sponsors were American Railway Engineering Association, American Society for Testing Materials, Structural Division of American Society of Civil Engineers, and the Wood Industries Division of American Society of Mechanical Engineers.

Shift to Cold Rubber



CHEMICAL PROBLEM . . .

. . . automobile tires that last longer under the heat and abrasion caused by today's higher operating speeds.

SOLUTION . . .

. . ."cold rubber," so called because it is made at 5° C. Cold rubber production requires a special emulsifier to bring together its basic ingredients—butadiene and styrene—under refrigerated conditions. The emulsifier found most satisfactory today, as when GRS-10 was introduced in World War II, is Dresinate®—one of many chemical materials produced by Hercules for the rubber industry.

COLLEGE MEN . . .

This is but one example of the far-reaching chemical developments in which you could participate at Hercules—in research, production, sales, or staff operations. It suggests the ways Hercules' products serve an ever-broadening range of industries and end-uses.

Hercules' business is solving problems by chemistry for industry . . .

. . . insecticides, adhesives, soaps, detergents, rubber, plastics, paint, varnish, lacquer, textiles, paper, to name a few, use Hercules® synthetic resins, cellulose products, chemical cotton, terpene chemicals, rosin and rosin derivatives, chlorinated products and other chemical processing materials. Hercules® explosives serve mining, quarrying, construction, seismograph projects everywhere.

HERCULES

HERCULES POWDER COMPANY Wilmington 99, Delaware
Sales Offices in Principal Cities

ME...
an AIRCRAFT engineer?

But I haven't majored in aeronautical engineering

That doesn't matter. Lockheed can train you... at full pay!

It's your aptitude, your knowledge of engineering principles, your degree in engineering that count.

Those—plus the opportunity Lockheed is offering you—are all you need for a career as an aircraft engineer. In Lockheed's special program for engineering graduates, you may go back to school, or you may convert to aircraft work by doing—on-the-job training. But whichever it is, you receive full pay while learning.

But Lockheed offers you more than a career. It offers you a new life, in an area where living conditions are beyond compare. Outdoor living prevails the year-'round. Mountains, beaches are an hour from Lockheed.

See your Placement Officer today for the details on Lockheed's Aircraft Training Program for engineers, as well as the better living conditions in Southern California.

If your Placement Officer is out of the illustrated brochures describing living and working conditions at Lockheed, write M. V. Mattson, Employment Manager

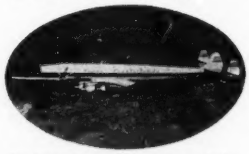
Lockheed Aircraft Corporation

Burbank, California

This Plane made History

The P-38 Lightning – first 400 mile per hour fighter-interceptor, the "fork-tailed Devil" that helped win World War II.

This Plane is making History



The Super Constellation – larger, faster, more powerful; the plane that bridges the gap between modern air transport and commercial jet transport.

This Plane will make History

This plane – which exists only in the brain of an engineer like yourself – is one reason there's a better future for you at Lockheed. For Lockheed will always need engineers with ideas, engineers with imagination, engineers who build the planes that make history.

David Scheraga ME '54
editor-in-chief
Irwin B. Margiloff ChemE '53
managing editor
Richard W. Wambach ME '54
business manager

◇

Publication Board

Henry F. Dimmler EE '54
assistant editor
Janice Button EP '54
associate editor
Robert M. Stuckelman EE '54
illustrations editor
George Edwards EE '55
treasurer
Marvin Zevin MetE '53
circulation manager
Richard Gons CE '53
advertising manager
Walter L. Jones EP '55
publicity manager
William C. Haugaard CE '53
office manager

Editorial Board

R. P. Allen ME '56
W. H. Bentley EP '54
M. D. Lapp EP '55
E. A. Leventhal EP '56
M. D. McIlroy EP '54
J. F. Schmutz ChemE '55
G. Wolga EP '53

◇

Business Board

R. J. Adams ME '55
R. S. Arlook ChemE '54
J. L. Beckel Arch '56
Y. Brazel EE '56
M. Cherkasky ME '55
F. B. DeGress ME '57
G. Haunalter CE '57
M. D. Inskeep ChemE '54
I. M. Jacobs EE '56
L. Pisnoy CE '57
R. A. Posner ME '55
W. C. Thurber MetE '55

◇

Illustrations Board

D. I. Ball CE '57
S. G. Beck EE '56
A. F. Cohen CE '55
D. Crook Arch '56
E. Matzal ChemE '56
R. C. Noyes ME '55
R. L. Rosenthal ME '53
R. L. Simon EE '54

◇

Advisory Board

Dean S. C. Hollister

Technical Advisors

Prof. R. Y. Thatcher
Prof. W. H. Erickson

School Directors

Prof. C. R. Burrows EE
Prof. N. A. Christensen CE
Prof. F. H. Rhodes ChemE
Prof. L. P. Smith EP
Prof. H. J. Loberg ME

Alumni

H. H. Williams, Jr. C.E.'26
W. H. Hill M.E.'22

Founded 1885

THE CORNELL engineer

MARCH, 1953 VOLUME 18 NUMBER 6

AT YOUR SERVICE 4

BEER 13
by Irwin B. Margiloff, ChemE '53

PROPERTIES OF AIR-ENTRAINED CONCRETE 17
by A. Sahap Yalcin, B.C.E. '51

BOOK REVIEW 19
by Professor Donald A. Stuart

CORNELL AERONAUTICAL LABORATORY 20
by H. S. Tolley

PRESIDENT'S MESSAGE 24

ALUMNI NEWS 25

SOIL TESTING—YARDSTICK FOR CONSTRUCTION 30
by M. D. Morris, C.E. '44
and John P. Gnaedinger, M.C.E. '46

BRAIN TEASER ANSWER AND LETTERS 38

TECHNIBRIEFS 46

ATOMIC ENERGY—1952 54

NEWS OF THE COLLEGE 58

MECHANICAL ENGINEERS—CLASS OF 1953 64

STRESS AND STRAIN 68

COVER—Triphammer falls and the Cornell Hydraulic Laboratory.
—Al Cohen

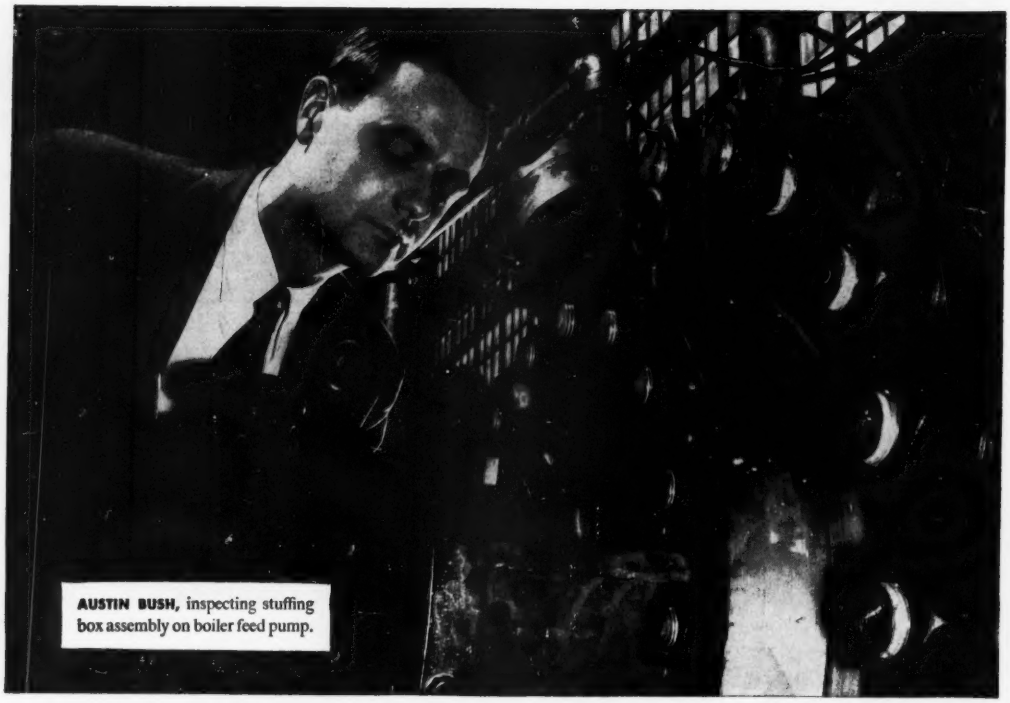
Member of The Engineering College Magazines Associated

Chairman: Prof. John Paustian, University of Nebraska, Lincoln, Nebraska
Publishers' Representative, Littell-Murray-Barnhill, Inc.
101 Park Ave., New York and 605 N. Michigan Ave., Chicago

Published monthly—October to May—by the CORNELL ENGINEER, Inc., Lincoln Hall, Ithaca, N. Y. Edited by the undergraduates of the College of Engineering, Cornell University. Entered as second class matter at the Post Office at Ithaca, N. Y., under Section 103, Act of October 3, 1917.

Subscription per year: regular $2.00; with membership in the Cornell Society of Engineers $3.00 (See President's page); student $1.50; single copy $.25.

Austin Bush, Rensselaer, '50, Helps Develop New Pump



AUSTIN BUSH, inspecting stuffing box assembly on boiler feed pump.

Reports interesting project engineering assignments at Worthington

"Despite its size as the leading manufacturer in its field," says Austin Bush, "I have found Worthington pays considerable attention to the interests of the individual. The company's excellent training program consists of several months of working with the various types of equipment manufactured, augmented by technical lectures, and talks on the organization of the corporation.

"Following this training, I was given an opportunity to choose the department in which I wanted to work—engineering, sales, or manufacturing. My choice was the engineering department where I have already been assigned to several interesting projects.

"In addition to the training program, the members of our engineering department hold monthly seminars at which engineering topics of general interest are discussed.

"Opportunities for advancement are good, and pleasant associates make Worthington a fine place to work."

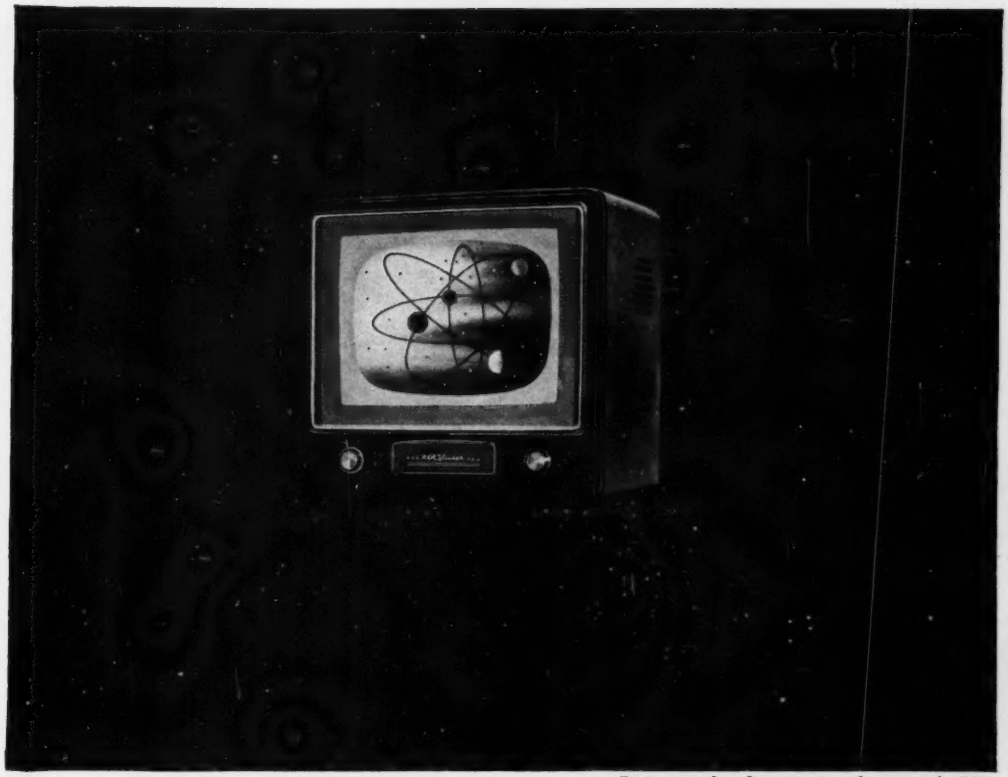
When you're thinking of a good job, think *high*—think *Worthington.*

FOR ADDITIONAL INFORMATION, see your College Placement Bureau or write to the Personnel and Training Department, Worthington Corporation, Harrison, New Jersey.

WORTHINGTON

The Sign of Value Around the World

2.54X



Basic research and engineering advances make RCA Victor's 1953 TV receivers the finest you can buy.

First with the major advances— since Television began!

Families living in television areas have seen from the beginning why more people buy RCA Victor television sets than any other brand. As television spreads to new communities, millions more learn the same.

Enthusiastic reception of the 1953 RCA Victor sets proves that advanced research and engineering means finer TV. You see it in the new "Magic Monitor" circuit system which *automatically* screens out interference, steps up power, tunes the best sound to the clearest picture.

Further proof of this leadership is the new RCA "Deep Image" picture tube with its micro-sharp electron beam and superfine phosphor screen which ensures the finest picture quality. It is also seen in reception at a distance—as well as in *automatic* tuning of all channels, both VHF and UHF.

Today's RCA Victor receivers result from the same research and engineering leadership that perfected the *kinescope* picture tube, the *image orthicon* TV cameras, reflection-free metal-shell picture tubes – and which opened UHF to television service.

• • •

RCA research assures you better value—more for each dollar you invest—in any product or service of RCA and RCA Victor.

CONTINUE YOUR EDUCATION WITH PAY—AT RCA

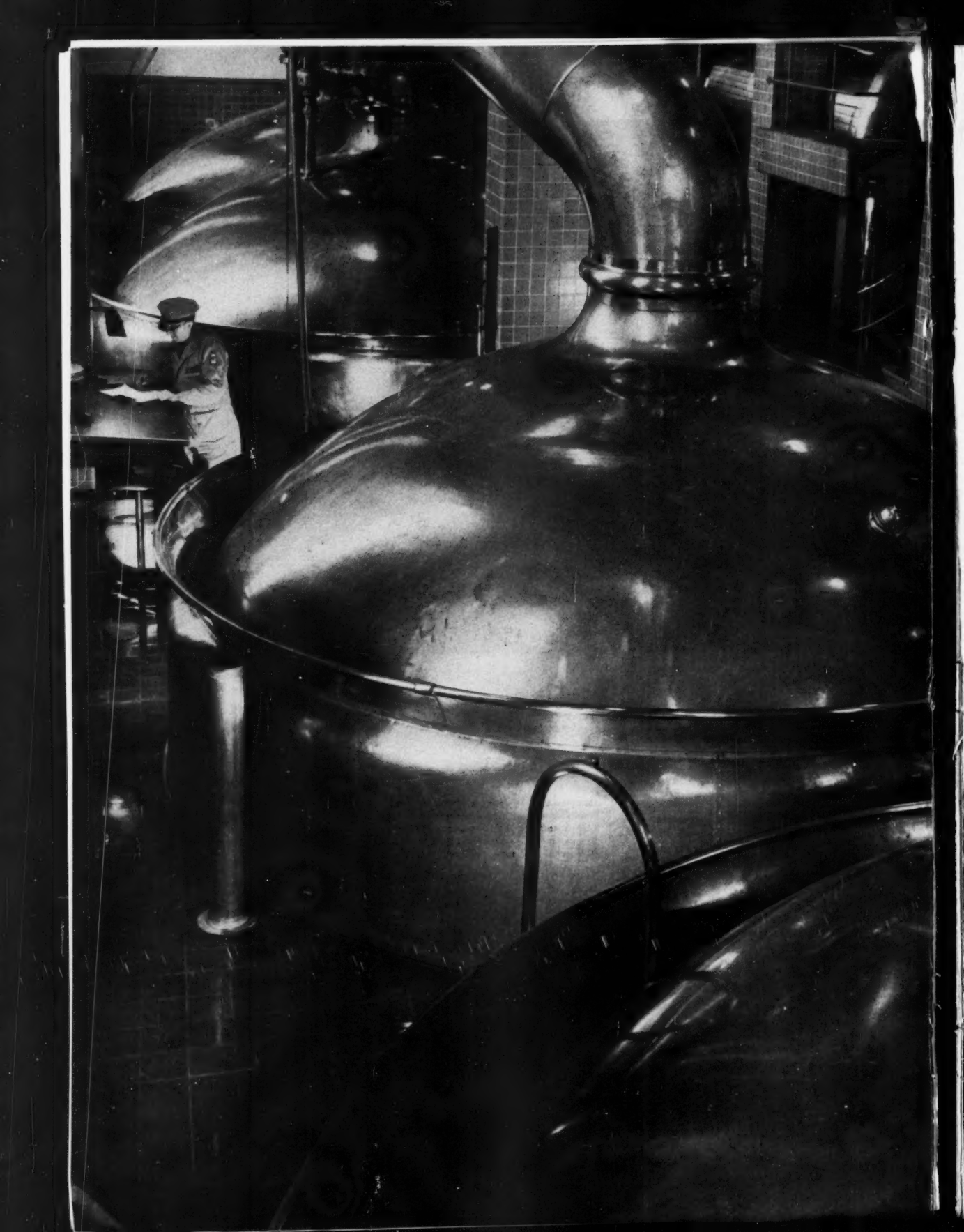
Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

- Development and design of radio receivers (including broadcast, short-wave and FM circuits, television, and phonograph combinations).
- Advanced development and design of AM and FM broadcast transmitters, R-F induction heating, mobile communications equipment, relay systems.
- Design of component parts such as coils, loudspeakers, capacitors.
- Development and design of new recording and producing methods.
- Design of receiving, power, cathode ray, gas and photo tubes.

Write today to College Relations Division, RCA Victor, Camden, New Jersey. **Also many opportunities for Mechanical and Chemical Engineers and Physicists.**

RCA® RADIO CORPORATION OF AMERICA

World leader in radio—first in television



BEER

MARGILOFF, ChemE '53

Photographs courtesy F. & M. Schaefer Brewing Co.

Because grain for fermentation has been available as long as has grain for baking, records show that civilized men have baked and brewed since the early days of recorded history—about 4000 B.C. The art of baking accompanied the brewers' art until late medieval times, when powerful brewers' guilds were built up. Early monasteries brewed beer for the inmates and for the thirsty countrysides—and the daily ration was about a gallon per day.

Brewing and baking were both women's business until about the twelfth century. The general steps in brewing were 1) grinding germinated barley (or other cereal grain) between stones, 2) adding water and making loaves with the dough, 3) baking at a low temperature, 4) grinding the loaves and adding water, 5) warming and fermenting the liquid, 6) filtering the fermented beverage from the bran through woven filters. Other grains which have been used in brewing are wheat, oats, rice, spelt, and corn; while fe[illegible] taste honey, herbs, and spices hav[illegible] been added.

Beer is an alcoholic beverage—a fermented extract of malt. Most popular in the United States are bottom-fermented lager beers. (Bottom-fermented—the yeast settles to the bottom during fermentation; lager—from German "lagern," to store.) Pilsener and Dortmunder beers are pale, have a medium hop flavor, pronounced carbonation, and a low alcohol content—about 3.0 to 3.8 per cent. Vienna beers are amber in color and have a very mild hop taste. Munich beers are dark brown; the malt flavor is fully developed and the hop taste is light. Porter, ale, and stout are made with different mashes and yeasts, but the brewing principles are alike, and the equipment used can be the same.

A series of copper brew kettles at Schaefer's Brooklyn plant. Here the wort is concentrated and the hops are added.

Bock beer, by the way, is not what is drained from the brew kettle once a year, as the old story goes. It is simply a beer made with one-third wheat malt and two-thirds barley malt. It was brewed first in Einbeck, Germany. The name was later corrupted to "Ein Bock," which in German means "a goat," and joyfully cavorting goats are still to be seen in bock beer advertising.

Brewers' Raw Materials

The raw materials for brewing are barley malt, adjuncts such as brewers' rice, corn, or starch, hops, brewers' yeast, and water. Barley malt is made by allowing wetted barley grains to germinate until the sprouts are about two-thirds as long as the grains themselves. The grains are then baked dark and crisp in ovens at 155°F for light beers and up to 220°F for dark beers. Adjuncts are an economical source of protein matter, starch, and enzymes, and may form as much as forty per cent of the weight of the dry charge to the mash tun.

Material Requirements

Tons per 1000 barrels of Lager Beer	
Malt	17-19 tons
Adjuncts (if used)	6-7
Yeast	½
Hops	¼-½

Hops are the dried cones of the hop plant, which is grown mostly in the Pacific States, and to a smaller extent in New York. While the use of hops dates back to the Second Babylonian Empire, their use became standard in beer about 1000 A.D. They impart the characteristic bitter taste to beer and improve its biological stability. From 0.4 to 0.8 pounds are used for each barrel of lager wort; 1.5 pounds per barrel is customary for ale and porter worts.

Brewers' yeasts are all pure strains of *saccharomyces cervisiae*. It was found in the course of the first systematic scientific experiments on beer in the last century that wild, adventitious yeasts could spoil batches of beer. Since that time brewers have cultivated pure strains and today sell as surplus a large excess grown during fermentation.

Until waters were analyzed carefully, the secret of the success of some European cities in brewing beer was a mystery to their competitors. Water for brewing must be potable; should be free of odor, color, bacterial or organic matter, and iron; and should have a medium amount of sulfate hardness. Some of the natural waters of Europe satisfied these requirements and produced good beer. Often the city water in American cities is good enough for brewing without any further purification.

Through The Brewery

We will follow the production of beer through a "typical" plant. While the procedures, materials, and equipment may not be identical with any one existing plant, enough similarity exists between the most diverse breweries to make this picture a generally accurate one.

Malt is brought from the malting

plant by railroad and is unloaded by vacuum systems into large atmospheric tanks or bins. The malt is ground to remove husks and polished to remove fines before being added to the cooker and masher. Hops are brought in smaller containers, since they are used in much smaller proportions in brewing. They are stored at 38°F to prevent loss of the volatile flavoring oils.

Brewers' rice is handled in much the same way as the malt. Not all brewers use adjuncts, however. Some pride themselves on producing a beer from malt and hops alone, but the beer is not necessarily better. It is a matter for the customer's taste to decide.

A thousand pounds of adjuncts and malt are passed through weighing hoppers to the cooker, where they are gelatinized for one to two hours with 7.5 to 9 barrels of boiling water. The temperature in a pressure cooker may be 275°F. The discharge passes to the mash tun, to which is added the main portion of the malt and more water. Mechanical agitation is provided. At 154°F —the conversion temperature—the malt enzymes convert the starchy materials into maltose, dextrin, and soluble starches. Mashing takes from 30 to 45 minutes.

Filtration of the mash may be done in a lauter tub or in a plate-and-frame filter press. The older device is the lauter—a large cylindrical tank with a perforated bottom. The grains from the mash tun are run in and settle, while the liquid extract, or wort (rhymes with hurt), runs through by gravity and enters the brew kettle. The first wort is usually pumped back, since the filter cake has not been built up and a sizable quantity of grains has gone through the perforated bottom. When the level of the wort has receded to the top of the layer of grain, sparging begins. Rotating racks plow up the bed of grains while they are sprayed with decarbonated water at 165°F.

The more usual filtering procedure in newer breweries is to pump the slurry of wort and grains through a plate-and-frame filter. The grains are washed until the malt extract content is one per cent. The first wort contains about 25 per cent malt extract. The washings are added to the now much-diluted wort in the brew kettle. The spent grains from both types of filters are dried with steam, bagged, and sold as feed for cattle.

The brew kettle is simply a large atmospheric boiler made of copper, provided with stirring, a steam jacket, and a door in the top through which the hops are added. The kettle may be as large as 25,000 gallons—800 barrels. Each hour the wort loses from eight to ten per cent of its volume. After 2½ to 3 hours, the concentrated wort contains a sludge of used hops and proteins coagulated by the minerals and tannins of the hops. This is the "first break." Boiling sterilizes the wort, destroys the enzymes formed in the cooking and mashing operations, and modifies the malty smell of the wort, which now contains the bitter hop acids, resins, and oils. The kettle can make eight batches a day, including time for cleaning between batches, and is often run 24 hours per day.

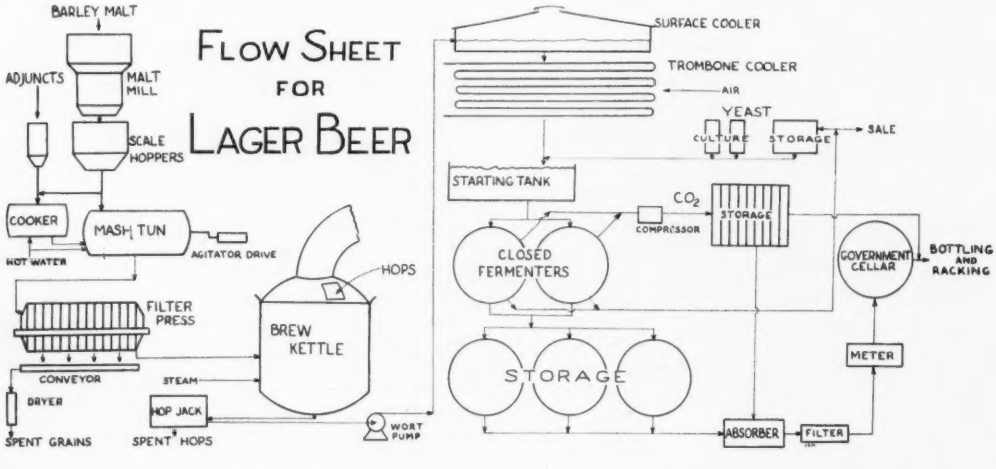
The sludge is removed in a hop-jack—a vessel in which the boiled wort passes through basket-shaped screens. Spent hops contain 30 barrels of wort per 1000 pounds of hops so these too are sparged in the hop jack. There is little use for spent hops. Even farm animals will not eat them.

Cooling and Fermentation

The hot wort at 180°F is pumped to the top floor of the fermentation plant, to cool by evaporation in a surface cooler, where it is usually not more than six inches deep. After this initial cooling it cools to 47° by cascading over a trombone cooler, commonly of glass, with ammonia or some other refrigerant in the tubes. A stream of purified and frequently sterilized air blows past the cooling wort to provide aeration for better fermentation. More protein matter and other insolubles are precipitated during this cooling, forming the "cold break."

Some breweries cool the wort in multipass copper heat exchangers.

The cooled, aerated, and clarified wort enters the first fermenting vessel, the open starting tank. This tank may be of wood, stainless steel, or glass-coated steel. Aerated brewers' yeast is pitched as a water slurry and fermentation of the sugars begins. The temperature is



Mash tuns, and cookers above, all of stainless steel. The malt, with hot water, and adjuncts is converted into a malt extract.

kept at about 43° by cooling coils. After 16 hours to a full day in the starting tank, the beer is pumped to closed fermenters—also provided with cooling coils—where from ten to fourteen days are allowed for complete fermentation. The carbon dioxide gas evolved is taken off, compressed, and stored at 250 pounds per square inch for later use in carbonating the finished beer. The yeast cells multiply and settle, so that at the end of the process there are more of them than at the start. Some yeast is stored at 40° after microscopic examination for wild strains, while the rest is sold as feed or to pharmaceutical houses for further processing.

During fermentation the pH of the beer drops from 5.2 to 4.5, and 260 Btu are liberated for each pound of sugar fermented. The yeast is especially active at 43-46°. A steady evolution of CO_2 gas is necessary to carry the foreign materials to the surface. The end of the fermentation period is determined by periodic tests for alcohol and sugar content; the final temperature is 55-60°.

The product drained from the fermentation tanks is "green" beer. It contains foam, hop resins in suspension, insoluble nitrogenous substances, and some yeast. This beer must be aged for six weeks to three months before it deposits the hard resins, and develops the full mellow taste and clarity of the commercial beverage. The beer ages in a large stock house, where the temperature is kept just above freezing.

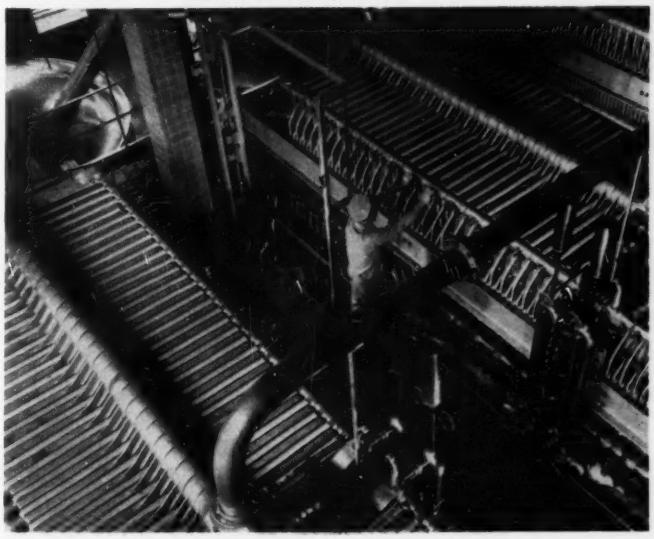
Carbonation and Bottling

After aging, the beer is carbonated with CO_2 gas until it contains 0.45 to 0.55 per cent by weight. Another, older method of carbonation is to introduce yeast and unfermented beer, and allow it to ferment in pressure tanks so that the gas evolved carbonates the beer. This process, called "kraeusening," is seldom used in modern American breweries. If this "natural" type of carbonation is used, the carbon dioxide gas given off in the closed fermenters may be used later on the bottling and racking lines to prevent contact of the beer with the air. The beer is given a final polishing filtration with some non-taste-imparting filter aid such as asbestos fiber. The yield is 970 barrels of finished beer for each 1000 barrels in the starting tanks.

Since American consumption of beer is carried on at low temperatures, chillproofing agents are sometimes added to prevent any precipitation of solids at temperatures just above freezing. This is, in fact, too low a temperature, since experts agree that beer tastes best at 40°.

Until this stage of the production of beer, no direct Government control has been exercised over its alcohol content. Some states have maximum allowable percentages of alcohol for a drink to be called "beer". All states and the federal government, however, are interested in the tax revenue of the alcohol. The lines carrying the aged beer to the bottling plant have federally-installed meters in them to keep an

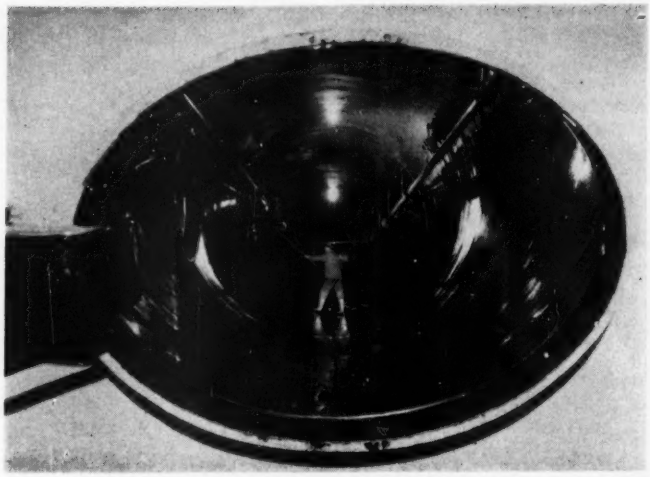
Part of a series of plate-and-frame filters. These units have sixty plates and can handle 600-barrel quantities of wort.



accurate check on the amount of alcoholic beverage to be bottled.

The beer is pumped to a refrigerated "Government Cellar" where tanks having a capacity of about a day's production are kept at 34°F and about 16 pounds pressure. These tanks supply the bottling and racking plants. Since the beer has aged, there is no need for larger capacities than these.

New and inspected used bottles are washed before filling. The bottles are placed in racks, bottoms up, which take them through the continuous washer. As they progress from one compartment of the soaker to the next, they are submerged in six per cent caustic soda solutions at temperatures rising gradually to 160°. This removes labels, gum, germs, and stale beer. After two fresh-water rinses, they proceed to the washer. In the first section, nozzles squirt water for a few seconds into the overturned bottles. In the next section they are brushed with a water spray, and in the last they receive a final water rinse. The treatment takes about 35 minutes for each bottle.



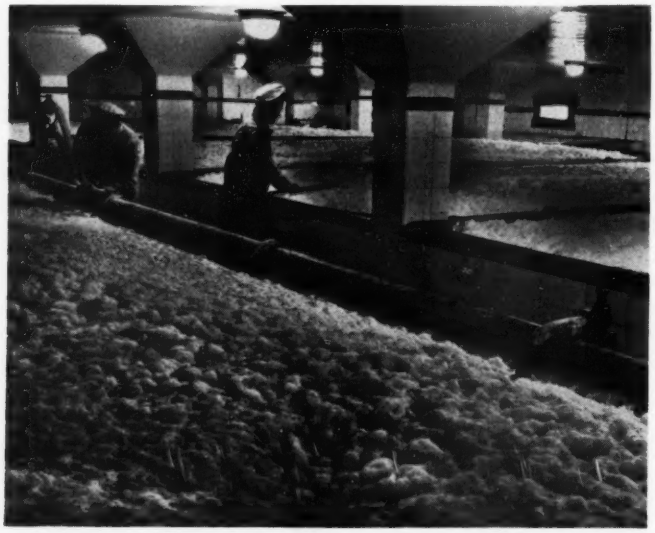
A workman cleans a 1000-barrel closed fermenter. The inside is glass-lined.

Cans and can lids are brought to the plant already printed and coated with a beer-resistant lacquer. Modern canning and bottling machines can handle about sixty barrels per hour, filling cans, 7, 12, and 32-ounce bottles. A separate racking plant fills half, quarter, and sometimes eighth "kegs." In this case a "keg" is synonymous with the standard 31-gallon barrel.

Filled bottles and cans are pasteurized for about forty minutes in a large pasteurizer, cooled gradually, and then packed automatically in cases and cartons. These are warehoused and distributed by railroad or by large trailer trucks.

The bottling plant has its own control laboratory for testing the air and carbon dioxide content of the finished and bottled beer. Cans are tested for the amount of exposed metal by measuring the current they allow to pass through a standard hydroquinone solution.

Open fermenters. Some breweries use these before finishing the fermentation in closed tanks. Foam is carried to the surface by the CO_2 gas evolved. The material is concrete.



Brewing Statistics

Economically, the brewing industry is a large force in our business life. There are about 450 breweries in the United States today, employing about 82,000 people on an annual payroll of $300,000,000. The annual cost of materials, fuels, and other production items is half a billion dollars, while annual taxes are almost a billion, or over $10 per barrel. The per capita consumption is 18.5 gallons per year. The total production is almost 100,000,000 barrels.

Properties Of Air-Entrained Concrete

By A. SAHAP YALCIN, B.C.E. '51

The technique of air entrainment in concrete has been developed in the relatively recent past, although there were instances in the past when extraordinary amounts of air were contained in the mix. In these accidents, the effects were either unobserved, or were attributed to natural variabilities characteristic of a material containing several different components. The effects now attributed to air entrainment were recognized in concretes as far back as the nineteenth century, but the technique itself is not more than fifteen years old. In 1937 it became apparent that some cements which were prepared in unusal ways produced concretes of great durability, and were of low density.

These air-entrained concretes showed durability in the sense that they were especially resistant to weathering, alternate freezing and thawing temperatures. Also, they were less subject to surface scaling, apparently because of their ability to lessen bleeding. In addition, this type of concrete proved to be quite resistant to scaling caused by chemicals applied to the surface for controlling ice. And it was noticed that these concretes were more workable with less segregation in mixing. The only disadvantage was that a reduction in compressive strength came about, further decreasing as the percentage of air was increased. However, since the water requirement was reduced by air entrainment, the water-cement ratio could be lowered by the proper redesign of the mix, thus retaining the desired strength.

Two Principal Methods

There are two principal methods of introducing air to the concrete mix. The first is cement dispersion; the second is by admixtures. Cement dispersion is done by adding dispersion agents during the manufacture of the cement. The dispersion agents are surface-active chemical compounds which are adsorbed in an oriented manner, preventing flocculation of particles in the mix by giving them like electrostatic charges. Surface reactions are important in cement. Dispersion increases the amount of surface per unit weight, thus allowing a larger area to be presented to the water, in this way improving the utilization of the cement. Also, water previously trapped in the particle clumps is released to become a part of the mixing or placing water. This results in a reduction in the ratio of water to cement. Some air is introduced into the concrete by dispersion. These dispersion agents are specific in their action, and an agent for one liquid-solid system may or may not be a suitable agent for another system. Calcium lignosulphonate is a widely used agent.

Effects of dispersion in the plastic mix are first to increase the mobility of the mix. This produces a more workable mix with a reduced water-cement ratio. Second, the cohesiveness is increased because of the greater specific surface. Cohesiveness improves the sticking of the cement paste to the aggregate, and thus prevents excessive segregation and consquently honeycombing. Third, better uniformity of the mix will decrease the formation of water pockets under large pieces of aggregate, which is a cause of bleeding or separation of fine and coarse particles.

In the hardened mix, the previously stated effects bring about greater homogeneity of the hardened concrete and a faster setting concrete by a more rapid hydration because of the greater specific surface. Since excess water brings about permeability and absorption, a decrease will make a concrete of the same cement content less permeable. Watertightness will result

ABOUT THE AUTHOR

The author, who is a native of Turkey, came to this country several years ago to study engineering at Cornell. He received his Bachelor of Civil Engineering degree in June, 1951, and is now working toward a Master's degree in Engineering Materials, with a minor in Highway Engineering.

The Master's thesis will be based upon his research project now being conducted on the study of soil stabilization by the use of calcium chloride. His professional interests are in working on soils, highways, concrete, and foundations.

He finds relaxation in less technical matters such as music; he has been an usher at many University concerts. Some of his activities at Cornell have included membership in the Music Committee of Willard Straight Hall and in the Graduate Student Activities Committee. He likes to sail on the Mediterranean when he goes back home.

A. Sahap Yalcin, B.C.E. '51

Fig. 2. **Deeper scaling of concrete—note loose aggregate and disintegration of sub surface.**

in a lower permeability. The surface of the hardened concrete is more corrosion resistant. The effects of freezing and thawing are reduced with better watertightness. Moderate amounts of entrained air — three to four per cent—make the concrete more resistant to damage from freezing of water in the pores, making a more durable concrete.

The second method of air-entrainment is the use of admixtures, which are ground with the cement clinker in the cement or directly added to the field batch. These additives are agents known as foaming or wetting agents, which greatly lower the surface tension of water. They ultimately form stable foams. Wetting agents are more or less complicated molecules composed of two essential parts, each forming one end of the molecule. One is the hydrophilic part; it draws the agent into the water phase. The other is hydrophobic and is attracted to a more non-polar medium. These molecules orient themselves in the interface, so that the hydrophilic part will be in water and the hydrophobic part will be toward the less polar components of the mix.

Any mechanical process that mixes a liquid with a gas tends to form a foam, although the bubbles may be of minute size and of short life. A foam is formed more easily with an agent which lowers the surface tension of the liquid, and becomes longer lasting. At the boundary between air or oil and water, the hydrophilic and hydrophobic parts orient themselves, creating a boundary film which lowers the interfacial tension and stabilizes any foam that is formed by mechanical action. In this way bubbles of air in the cement paste are stabilized.

Air Entrainment Agents

Agents which are used for the entrainment of air are wood resins such as Vinsol resin, soaps, fats and oils, wetting agents, sodium salts, and petroleum sulfonic acids; hydrogen peroxide and aluminum powder have been used to entrain oxygen and hydrogen in the mix. For most field projects, the agent is used interground with the cement clinker. The method of adding an admixture to the mixing water is limited. The former method is more practical and more economical. If the latter method is used, the agent is in powder form. This powder should be mixed with a liquid, then poured into the mix. Vinsol resin, which is a powder, for instance, must be mixed with a sodium hydroxide solution before being added to the mix.

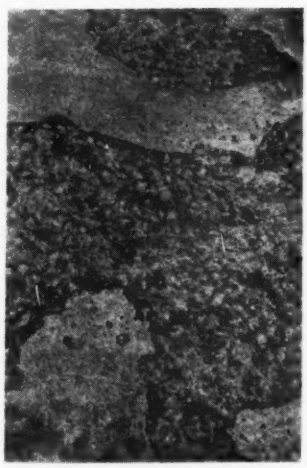
Use of one of the above foaming agents is attended by some disadvantages, particularly losses in strength. But, as explained before, by a proper redesign of the mix, the desired strength may be retained.

The most desirable range of air content is usually given as three to seven per cent by weight. By cement dispersion only three to four per cent of air can be entrained; dispersion agents such as calcium lignosulphonate act more as a dispersion agent for the cement than as wetting agents reducing the interfacial tension between the water and air phases. In the dispersion method, although the per cent of entrained air is lower, some economy is effected because of the reduced requirement for cement. On the other hand, by the use of air-entraining agents such as Vinsol resin, the higher limits of air—five or more per cent—can be attained.

Physical Properties

It should be pointed out that the increased durability of air-entrained concrete is brought about by the air itself, and not by the agent directly. The size of the fine aggregate affects the percentage of entrained air; usually 14 mesh is the largest size of particle to affect the amount of air entrained. The percentage of sand by weight of total aggregate may be reduced by one per cent for each per cent of entrianed air up to eight per cent without appreciably affecting the workability. It is important to note that crushed and angular aggregates entrain more air than rounded aggregates — about half again as much for the same amount of resin added.

Fig. 1. **Typical scaling of concrete pavement—light areas are patches of original surface.**

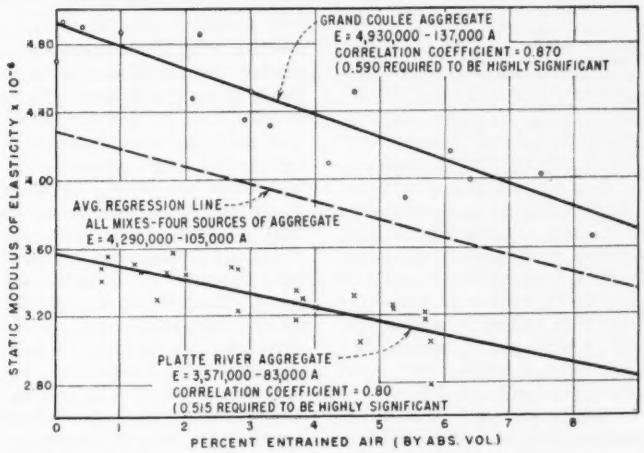


Entrained air improves the workability. In lean mixes—those with cement contents of about 4.5 sacks per cubic yard — this increase in workability raises the compressive strength slightly up to an air content of five per cent. In richer mixes made with 5.5 and 6.5 sacks per cubic yard, the compressive strength falls off sharply with increasing air content.

The static modulus of elasticity is decreased by a rise in air content. The modulus of rupture decreases as the amount of air increases. A temperature effect is also noticeable; more air is entrained by concrete at a lower temperature than at a higher temperature at the time of mixing.

Durability tests are usually conducted to show the variation of surface scaling, dynamic modulus of elasticity, per cent expansion, and loss of weight. With increasing number of cycles of freezing and thawing, a slight scaling can be noticed for air-entrained concrete, while normal concrete scales badly at less than ten per cent of the number of cycles required for bad scaling of air-entrained concrete. The dynamic modulus of elasticity stays essentially unchanged or may increase very slightly with the number of cycles, whereas in the normal concrete this modulus decreases rather quickly.

Fig. 4. **Relationship between modulus of elasticity and air content.**


GRAND COULEE AGGREGATE
E = 4,930,000 - 137,000 A
CORRELATION COEFFICIENT = 0.870
(0.590 REQUIRED TO BE HIGHLY SIGNIFICANT
AVG. REGRESSION LINE
ALL MIXES - FOUR SOURCES OF AGGREGATE
E = 4,290,000 - 105,000 A
PLATTE RIVER AGGREGATE
E = 3,571,000 - 83,000 A
CORRELATION COEFFICIENT = 0.80
(0.515 REQUIRED TO BE HIGHLY SIGNIFICANT
STATIC MODULUS OF ELASTICITY x 10⁻⁶
PERCENT ENTRAINED AIR (BY ABS. VOL)

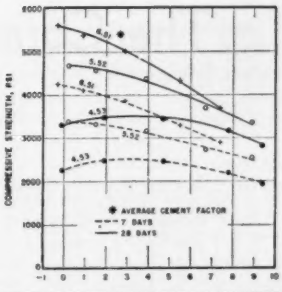


Fig. 3. **Relationship between air content and strength.**

Summary

Air entrainment refers to the presence of small bubbles of air, approximately one ten-thousandth of an inch to several hundredths of an inch in size, dispersed throughout the paste of concrete and primarily attached to particles of aggregate. It increases workability, increases resistance to freezing and thawing damage, and increases resistance to scaling. The mix should be redesigned to prevent loss of compressive strength. Various organic materials, in extremely small amounts, either interground with the clinker, or added with the mixing water, cause the entrainment of air in concrete.

BIBLIOGRAPHY

W. A. Cordon, *J. Am. Concrete Inst.* 17, No. 6,605 (1946).

L. E. Andrews, *J. Am. Concrete Inst.* 17, No. 6,621 (1946).

A. T. Goldbeck, *J. A. Concrete Inst.* 17, No. 6,649 (1946).

E. W. Scripture, Lecture on Concrete Dispersion (Master Builders Company, Cleveland, O.).

Book Review

Structure of Metals *by C. S. Barrett. 2nd edition, McGraw-Hill Book Co.*

To the physicist currently engaged in research in the theory of solids and/or crystallography, Prof. Barrett's book needs no introduction, and a revised, second edition is to be welcomed with open arms. His first edition has been a classic in its field. However, in nine years, any book as complete and as concerned with current theories as this one can be expected to become obsolete and to require revision in many ways.

This revision, *Structure of Metals*, is in a sense, two complete books in one. The first half concerns itself with X-rays, crystal structure, and the determination of structure by means of X-rays. The second half of the book discusses the structure of metals, super-lattices, plastic deformation, dislocation theory, effect of cold work upon structure, and phase transformations. However, since the results obtained by X-ray studies are used throughout, the text is effectively welded into a single unit.

The practical-minded person might well say: "All the material covered in this book is interesting and up-to-date, but how will the book aid me in building a better machine?" Unfortunately, the only answer to this question is the same that can be given for any aspect of "basic" science. The book itself can help only insofar as it aids you in understanding the basic concepts underlying the behavior of metals. It will not tell one directly what he must do to make a better alloy. Thus the book will be of primary use and interest to the researcher rather than the builder. Even so it is to be highly recommended to anyone interested in this field.

By Derald A. Stuart, Assoc. Prof. Engineering Mechanics and Materials

The Cornell Aeronautical Laboratory

By H. S. TOLLEY
Department of Public Information

Photographs Courtesy of the Laboratory

In a previous article, the history of Cornell Aeronautical Laboratory (C. A. L.) was briefly presented. In this article, a more detailed description will be given of what the Laboratory is and does. As previously noted, the Laboratory's charge by dedication is "An instrument of service to the aircraft industry—to education—to the public at large." In practice, this broad assignment falls into four specific assignments—to: 1) perform research and development tasks for industry and government, 2) contribute to fundamental scientific knowledge, 3) be financially self-sustaining, and 4) contribute to education. In its seven years of existence, the organization has demonstrated that it can meet all of these responsibilities.

Today the Laboratory stands as a self-sustaining organization with a capital value of about six million dollars, deriving income from research contracts in the general field of the aeronautical sciences and their application. Since traditionally the majority of aeronautical research is directly or indirectly supported by government, the bulk of Laboratory activity is pursued under government sponsorship. Presently the highest percentage of sponsored research at C. A. L. is under Army Ordnance, Air Force, and Navy contracts. Considerable research is done for additional government agencies as well as for various commercial firms. Of late, the Laboratory has increased its emphasis on industrial research, as witnessed by the formation of an Industrial Division approximately a year ago.

Technical Program

Although pursuing significant fundamental research, the Laboratory is primarily devoted to an applied research and development program. As an applied research laboratory, it bridges the gap between fundamental knowledge and eventual manufacturing development. Obviously, recent efforts have been focused on vital problems of national defense. Security restrictions limit description of much of the work, but a listing of the Laboratory's general areas' of research and development effort for industry and government would include:

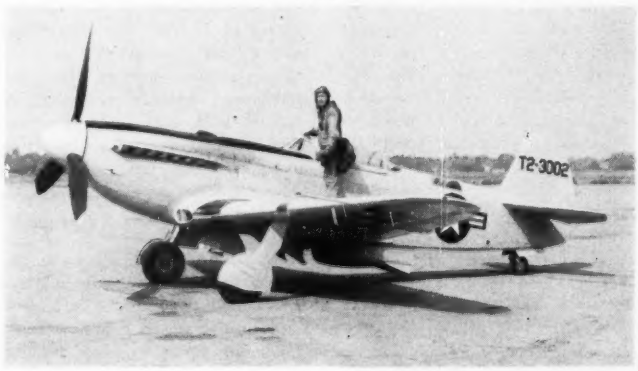
Aerodynamics
Aeroelasticity and Flutter
Aircraft Design
Applied Physics
Armament
Electronics
Flight Research
Guided Missile Programs
Heat Transfer
Helicopter Research
Instrumentation
Materials and Structures
Operations Analysis
Propulsion
Physical Systems
Safety Research
Tactical Air Operations Program
Wind Tunnel Techniques
Wind Tunnel Testing and Research in Wind Tunnel Techniques

C. A. L. has operated its 8½-foot by 12-foot variable density, high subsonic wind tunnel for testing by both the aircraft industry and government agencies. A substantial amount of testing of various aircraft models, guided missiles, and high speed propellers has been carried out. In the wind tunnel operation, there has been constant emphasis upon the development of better instrumentation for measuring forces and moments, new equipment to record strain gage readings automatically on IBM cards and practical means of photographing shock phenomena in supercritical flows. The determination to keep the tunnel technologically advanced is exemplified by the recent installation of a high speed propeller dynamometer permitting testing of single or contra-rotating propellers in the transonic and supersonic speed ranges. In addition, modification of the tunnel itself to enable production of shock-free transonic flows has been undertaken.

In the field of aerodynamics, considerable emphasis has been devoted to the new phase of aerodynamics at supersonic speeds. Work has recently included studies on wing and body interaction at supersonic speeds, a hypersonic impulse-type tunnel, air exchange problems in supersonic tunnels, boundary layer characteristics at supersonic speeds, and gasdynamics of supersonic jet engines. C. A. L. has also studied the problem of obtaining subsonic aerodynamic data on the low-aspect-ratio swept wing configurations used in supersonic aircraft missiles. In addition, considerable emphasis has been directed toward investigating the phenomena of aerodynamic heating, and of heat transfer at high air velocities.

Research has been conducted on

Fig. 1. Yak 9 aircraft with U.S. markings at C.A.L. as part of a foreign aircraft evaluation project.



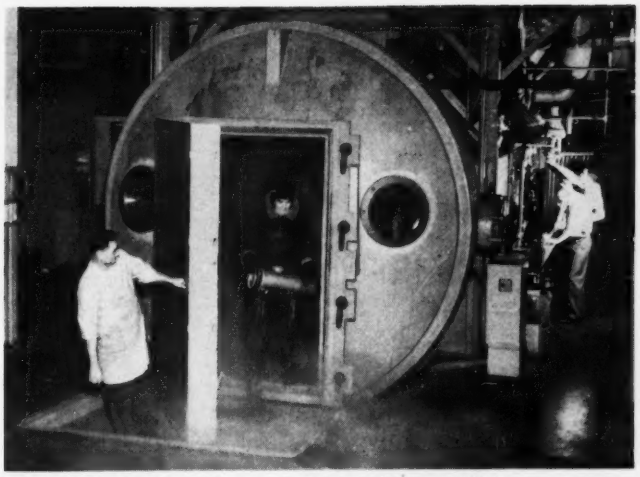


Fig. 2. **Altitude chamber capable of simulating conditions at 60,000 feet and temperatures of –80F.**

some of the newer propulsion devices, such as ramjets and pulsejets, ranging from the fundamentals of chemical kinetics of combustion to the development of practical propulsion devices. It is noteworthy that in investigating flame structure, an interesting observation was made that cellular flame structure plays a decisive role in the spontaneous excitation of organ-pipe oscillations by flames propagating in tubes. Depending on the type of propulsion device, such vibration may be desirable or undesirable, but their control is in any case an important engineering problem. On the basis of knowledge gained about wave phenomena from the fundamental gasdynamics investigations, the Laboratory has developed various new types of pulsating flow engines. Among these is an interesting and simple engine known as the valveless pulsejet, in which resonating combustion is maintained without the aid of any moving part.

Laboratory Activity

Technical activity has included study in aeroelasticity and flutter. Both theoretical and experimental work has been done to explore the effects of supersonic speeds, finite aspect ratio, nacelles, fuselage degrees of freedom, concentrated masses and sweepback on flutter, and other aeroelastic phenomena. Since an important question as to the validity of flutter analysis is the accuracy of the unsteady aerodynamic theory, research has also been pursued to measure directly the aerodynamic forces in the frequency range of interest to the aeroelastician and to correlate these results with theory.

There have been notable efforts expended upon revising and developing automatic control equipment for airplanes, helicopters and guided missiles. Of particular interest was an investigation leading to the development of a control system for a helicopter that assists the pilot by automatically coordinating engine throttle with blade pitch in order to maintain constant rotor speed. Typical work in this field has included development of an automatic system for remote control of bombing aircraft, guidance systems for guided missiles, and a large scale development program on servomechanisms.

Dynamic stability and control research has long been an extensive program of flight research. This work represents the most comprehensive effort yet made to develop methods and techniques for extracting basic dynamic stability parameters from aircraft in flight and to utilize these data for the improvement of both the manually and the automatically controlled flying characteristics. As well as the flight test program to measure dynamic characteristics, the Laboratory has conducted flight research on related work in gust determination, the characteristics of unconventional aircraft, the dynamics of the stall, structural design criteria, foreign aircraft evaluation and artifical stability and control.

Extensive research has been conducted in materials and structures. High temperature metallurgy investigations have been conducted to determine the physical properties and mechanism of failure for various metals at high temperature under static and dynamic stresses. Another investigation involved testing a wide variety of materials including metals and experimental polymers and elastomers at high speeds in simulated rainfall to determine the erosion suffered. Other efforts have included an evaluation of corrosion resistance of various protective coatings for materials and an investigation into the methods of brazing titanium and titanium base alloys. Considerable work has been done on structural laminates consisting of plastics reinforced with glass cloth and this study has produced a new material with about half the weight of aluminum but with the strength properties necessary for use in aircraft structural components. Another typical investigation involved the study of promoters for polyester resins and their use in fabricating plastic items.

Projects in electronics—a major field of study—have included the development of automatic tracking circuits for radar, and development of telemetering systems (radio and television) providing instant reception on the ground of test data from an airplane in flight. C. A. L. also developed underwater television and operated this equipment at the Bikini bomb blasts. Other work has been done on instrument approach systems, automatic pilots, and subminiaturized electronic components. Problems in communication have been investigated with contribution in the design of frequency modulation receivers with automatic frequency control, methods for the reduction of radio noise, aircraft antennas, and amplitude-modulated subcarrier circuits. In addition, research has been conducted on aircraft instruments such as accelerometers, pressure gages, computers, and control-position and

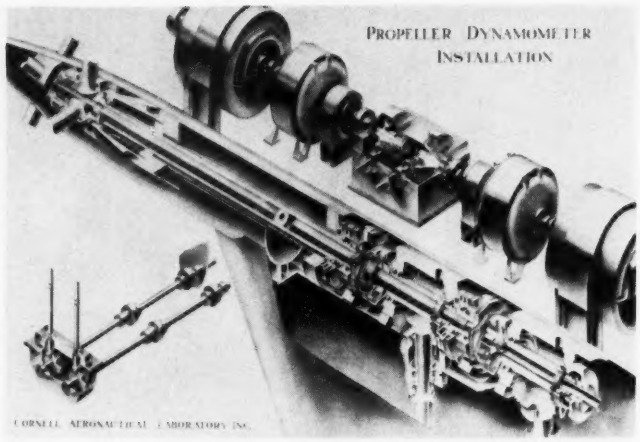
control-force indicators.

The research program has always placed emphasis on studies in safety. Under guidance by the Cornell Committee for Transportation Safety Research, at one time known as the Cornell Committee for Air Safety Research, typical work has included a head impact investigation to determine the human skull's resistance to blows, a study of the kinematics of the human body in crash deceleration, research on padding materials, and the development of protective head gear and other materials. It should be noted that the helmet worn by Cornell's football team in recent years was developed and fabricated by C. A. L. This helmet employs a radically new type of padding known as "beampad" and a suspension system termed "geodetic" which distributes the shock of impact and effectively absorbs energy of impact.

In the broad fields of operation research and system analysis, which are having an impact of aircraft and other military operations, studies have been made of aircraft performance and air traffic trends, air traffic control systems, air warfare systems, missile systems, and aircraft vulnerability.

To conclude this summary, it should be noted that there are several blocks of applied research that stand in or upon the verge of present commercial use. These items include large inflated radomes, improved aircraft hydraulic equipment, lean alloys for high temperature use, high temperature strain gages, improved crash helmets, and other protective padding materials or devices.

Scale model B-29 mounted in the large wind tunnel.



2,000 horsepower propeller dynamometer.

Technical Organization

The technical effort of Cornell Aeronautical Laboratory, Inc., as sampled above, are carried out by seven departments and two divisions. In advertisements to appear in the ENGINEER, these technical groups will be described. For this present article, they are merely listed as the Aerodynamic Research, Aero-Mechanics, Flight Research, Materials, Physics, Special Projects, and Wind Tunnel Departments, and the Development and Industrial Divisions.

The Laboratory's dedication includes a responsibility to education. What then is the educational relationship between it and the University? A university's traditional responsibility is to pursue research. Cornell University through the Cornell Aeronautical Laboratory is able to expand this important function by engaging in the applied type of research as distinct from the more fundamental research on campus. Then, too, the Buffalo Laboratory is able to undertake research contracts for the government, which because of security restrictions, would hardly be appropriate for a college campus with its tradition of academic freedom.

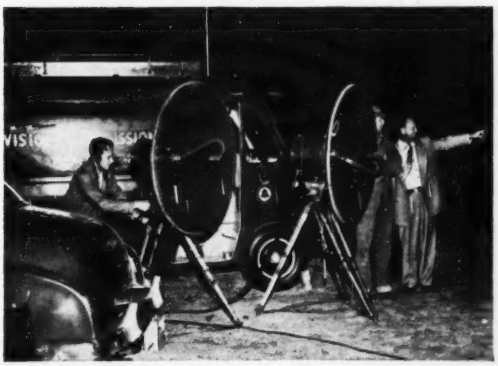
Directly counted among the organization's educational activities is a summer employment program. In this program a number of university students (from Cornell and others) are hired to participate in the technical program, affording them practical experience in their academic fields. They are largely graduate students. During the past summer, the Laboratory employed forty-five students from twenty-one different universities. Twelve were Cornell students.

Many universtiy professors are consultants to the Laboratory and some are employed during the summer on a full-time basis. Each year the Laboratory also supports eight graduate fellowships to the University. The support of these fellowships falls within the general framework known as C. A. L. Research Associates, of which the original sponsoring aircraft companies are members.

The way is open for additional companies to enter into this program by contributing to the Laboratory's working capital. In such cases, the further fellowships would be supported at Cornell in the name of the sponsoring company. As a further educational role, certain members of the staff have lectured at the University from time to time, just as the University faculty often presents seminars in Buffalo. At one time, Cornell faculty members gave accredited courses in Buffalo to members of the C. A. L. scientific staff. Graduate study is encouraged locally through a partial tuition refund program.

In concluding this second article on Cornell Aeronautical Laboratory, Inc., it is hoped that through a brief look at the Laboratory's heart beat, some general insight has been given into what C. A. L. is and does.

earthquake!



Precisely at 4:50 A. M. in the predawn darkness of last July 21, the most severe California earthquake since 1906 struck the small town of Tehachapi.

Walls were collapsing, buildings were folding. The town's telephone office shook to its foundation and the lights went out. But the night operator remained at her switchboard until it went dead. Main cables to the telephone office were pulled to the ground when a nearby wall caved in.

This was at 4:50 A. M.

At 8:30 A. M., less than 4 hours later, telephone men had reestablished 3 circuits on the edge of town (top picture). Outdoor offices were set up for Red Cross and other emergency workers.

Repairs to the damaged main cable and other equipment were rushed (center picture). By late afternoon the central office switchboard was working. Tehachapi residents were able to make calls to friends and relatives concerned about their safety.

By 9 P. M., two TV stations were sending live telecasts of the damage to Southern California viewers (bottom picture). Telephone men had established a 4-jump radio-relay station in less than 12 hours.

It was a typical disaster—brutal and unannounced. But telephone men were prepared. They quickly restored communication when it was needed most. In so doing, they demonstrated the resourcefulness and technical skill which telephone companies ask of their engineers.

For qualified engineering graduates of this caliber, there are opportunities in the telephone companies. Your college placement officer can give you details. Or write to American Telephone & Telegraph Company, College Relations Section, 195 Broadway, New York 7, N. Y., for the booklet, "Looking Ahead."

BELL TELEPHONE SYSTEM

CORNELL SOCIETY OF ENGINEERS

107 EAST 48TH STREET 1952-53 NEW YORK 17, N. Y.

KARL J. NELSON, Ch.E. '39, *President* .....321 North Avenue East, Cranford, N. J.

THOMAS W. HOPPER, M.E. '29, *Executive Vice-Pres.*....1700 Sansom St., Phila. 3, Pa.

WALTER M. BACON, E.E. '30.....*Recording Secretary and Secretary-Treasurer*
510 East 84th Street, New York 28, N.Y.

Philadelphia Branch
SEABURY S. GOULD, *Vice-President* .....2099 North 63rd St., Philadelphia 31, Pa.

New Jersey Branch
JOHN WEIKERT, Ch.E. '42, *Vice-President* ....714 Woodland Avenue, Westfield, N. J.

Detroit Branch
PHILIP J. KENT, M.E. '14, *Vice-President* .....P.O. Box 1919, Detroit 31, Mich.

St. Louis Branch
SHURLY R. IRISH, M.E. '18, *Vice-Pres.* ....307 South Gore Ave., Webster Groves, Mo.

Chicago Branch
WILLIAM J. MAUER, C.E. '09, *Vice-Pres.* ....503 North LaSalle St., Chicago 10, Ill.

New England Branch
HENRY GALLY, JR., C.E. '34, *Vice-President* .....14 Ingersoll Road, Wellesley, Mass.

Honorary President: S. C. Hollister, Dean of the College of Engineering

Honorary Vice Presidents:
C. R. Burrows, Director of the School of Electrical Engineering
N. A. Christensen, Director of the School of Civil Engineering
H. J. Loberg, Director of the Sibley School of Mechanical Engineering
F. H. Rhodes, Director of the School of Chemical and Metallurgical Engineering
W. R. Sears, Director of the Graduate School of Aeronautical Engineering
L. P. Smith, Director of the Department of Engineering Physics

K. J. Nelson

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students and to establish closer relationship between the college and the alumni."

The ENGINEER reported recently the unexpected death of Paul O. Reyneau. This brought to a close a long career of outstanding service to Cornell and its alumni. For the past eighteen years he was Director of the University Placement Office in New York City, and since 1938 he served continuously as the secretary-treasurer of our Society. In addition, he participated in many other Cornell activities.

The Alumni Placement Service developed by Paul in New York is one of the few tangible services provided by the University for its alumni. The benefits of finding desired employment positions for competent personnel are self-evident to the many alumni and companies which use this service. Of equal importance, however, were the benefits derived by Cornell itself since this service provided the unusual opportunity for improving the University's relations with its alumni and with business and industry. Good relations in these areas are recognized as being vital to the future life and development of Cornell. Paul was always aware of his responsibilities in these relationships and performed a magnificent job. The success he achieved is revealed in the many letters of appreciation and commendation he received from both alumni and companies. Part of his service was in the field of counselling, and it is interesting to note that as many letters were received from those who found new employment as from those who did not. These essential services and excellent relationships should be preserved and expanded.

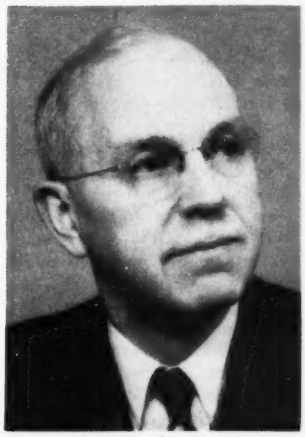
The Society of Engineers was particularly indebted to Paul. This organization has grown to well over 3,000 members located in many countries, and it has local sections operating in seven major cities in the U. S. It also has close contact with operations in Ithaca. Effective management requires day-to-day handling of its affairs. Paul performed this task skillfully and with enthusiasm. In addition, his continuous service in this key position provided the Society with the benefits of a permanent management, even though most of the other officers served only one-year terms. These contributions coupled with his sound advice and guidance were largely responsible for the growth of the Society and its service to Cornell and Cornell Engineers.

K. J. NELSON

Alumni News

Hyron Fred Beardsley, M.E. '14, of 60 Prospect Ave., Irvington, N.J., died on October 3. He had been a mechanical engineer for eighteen years with Standard Oil Development Company.

Paul W. Thompson, M.E., '10, has been elected executive vice-president of the Detroit Edison Company. He relinquishes his duties as vice-president in charge of engineering, construction, and operations. Mr. Thompson has been with



Paul W. Thompson

Detroit Edison since 1913. In 1931 he was made chief engineer of power plants. In 1943 he was elected vice-president in charge of engineering, construction, and operations.

Charles E. Reese, C.E. '20, is a civil engineer with Turner Construction Co. in New York City and lives at 22 Herning Avenue, Cranford, N.J. Charley has a daughter and two grandchildren.

William Spivak, C.E. '20, of 8714 Twenty-first Avenue, Brooklyn, is a civil engineer with the office of the President of the Borough of Brooklyn. He has two daughters and is active in engineering societies and war veterans' organizations.

David L. Eggers, B.Arch. '42, became a member of the firm of Eggers & Higgins, 100 East Forty-second Street, New York City, consulting architects on Annabel Taylor Hall at Cornell. He is a director of the Larchmont Federal Savings & Loan Association.

Anthony E. Sprague, M.E. '49, recently became a product designer with Norberk Manufacturing Co. His address is 3711 South Logan Avenue, Milwaukee, Wis.

Frederic A. Jessen, Jr., E.E. '50, is a civilian project engineer in electronics with the Navy on the West Coast.

Richard P. Przybyl, E.E. '50, of 1382 Sycamore Street, Buffalo, is an electronic engineer with Sylvania Electric Products, Inc.

Henry C. Thorne, Jr., B. Ch.E. '51, is a junior member of the American Institute of Chemical Engineers. He is employed by Standard Oil Co., Whiting, Ind., as a process engineer.

Stanley R. Stager, Chem.E. '36, has been made manager of the du Pont Company European Office, with headquarters in London, with general responsibility for the du Pont activities in England, Holland, Belgium, Switzerland, France, and Western Germany. The Stagers left the United States on the Queen Mary on September 10.

James M. Goodwillie, B.S. in A.E. '42, son of former Alumni Trustee Edward E. Goodwillie '10, has been promoted to assistant district manager, building materials division, Armstrong Cork Co., 295 Fifth Avenue, New York City.

Sol Ruben, Chem.E. '42, is technical director for Belco Industrial Equipment Division Inc. at Paterson, New Jersey. Sol is co-author of a chapter on instrumentation in the book of "Extrusion of Plastics" by H. R. Simonds.

William V. Wagner, Chem.E. '49, was in Olin Hall recently. Bill is with the research and development division of the Arabian-American Oil Company at Dharan, Saudi, Arabia. Bill and Mrs. Wagner came back by boat; they left Arabia on October 27, and arrived in the United States on Thanksgiving Day. They returned for another two-year term on January 6. Bill seems to like Arabia, although he admits that it gets a little warm when the thermometer climbs to 120°F.

Robert G. Lyon, M.E. '34, has been appointed account executive in the Detroit office of Ross Roy Inc. He has been working on the Dodge Truck account for the past

R. G. Lyon

several months since he was moved up from product research which he headed soon after joining Ross Roy, Inc. in October, 1948. He is a specialist in automotive engineering with considerable experience in the truck business.

George B. Howell, M.E. '42, has been named manager of manufacturing for the General Electric Company's Welding Department at Fitchburg, Mass., according to a recent announcement by Raymond C. Freeman, general manager of the department.

Formerly superintendent of manufacturing for the department, Mr. Howell succeeds Thomas Sproule who has joined the GE Manufacturing Services Division.

A native of Schenectady, N. Y., he was graduated from Cornell University in 1942 with a degree in mechanical engineering. He served three years in the U. S. Army, joining General Electric as a student engineer on its Test Course in Pittsfield, Mass., in 1946.

After various assignments in Pittsfield and the company's plants in Lynn, Mass., Mr. Howell was appointed purchasing agent for the GE Lighting and Rectifier Department in 1950. A year later he was named superintendent of manufacturing for the Welding Department, the position he held until his present appointment.

David L. Caldwell, Chem.E. '43, is project manager in charge of the design of the new synthetic ammonia and urea plant that is being built by the Foster-Wheeler Company for John Deere and Company at Pryor, Oklahoma. The plant involves a series of new processes for making ammonia and urea from natural gas.

John A. Newman, Chem.E., '43, '44, has resigned from Shell Oil Co. to open private consulting offices in Houston, Texas, specializing in oil and gas development and evaluation engineering. He and his family live at 3824 Belfontaine in Houston.

John T. Parrett, M.E. '44, has established his own engineering development business, Parrett Co., 431 West Main Street, Benton Harbor, Michigan.

J. E. Edison, Chem.E. '45, is field engineer with Sun Oil company and is engaged in offshore drilling and production work. Jim reports that he has been doing some creative writing, and that he is the author of a recent article, submitted to the Sun management on "Why I Am Worth More Money."

Roger S. Chamberlin, Chem.E. '45, 50, formerly research and development engineer, has been promoted to project leader in the chemical engineering department of Dow Chemical Co. He and his wife and child live in Lake Jackson, Texas.

Leonard J. Edwards, Chem.E. '46, is assistant works manager for the Henderson, Nevada plant of the Stauffer Chemical Company. The plant makes chlorine and chlorinated organics.

George B. Howell

Gordon K. Dingle, M.E. '47, research engineer at Northrop Aviation Corp., writes, "Got married on my birthday, October 21, 1952, to June Anderson of Grand Rapids, Michigan, stewardess for American Airlines; honeymoon in Las Vegas, Nevada, tremendous time, made money." Their home is at 228 Twenty-third Place, Manhattan Beach, California.

Fernando Cordovez, Chem.E. '48, living at Hacienda Santa Teresa, El Consejo, Aragua, Venezuela, is plant superintendent of a sugar mill and sugar refinery which grinds 1000 tons of cane a day.

David F. Woods, M.E. '48, son of the late David S. Woods, '04, has joined the Los Alamos Scientific Laboratory of the University of California in the weapons division. He lives at 2013-A Twenty-second Street, Los Almos, N. Mex.

James Whitley Ellison, Arch. '49, has announced the opening of offices for general practice at 200 Broadway, Seattle 22, Washington.

Eric W. Kjellmark, Chem.E. '49, '50, was released from active duty December 14, and has returned to work at E. I. DuPont de Nemours and Co. experimental station, Wilmington, Del.

Donn Skoog, Chem.E. '50, was discharged from the U. S. Army on January 4, 1953, and returned to Polychemicals Division of the DuPont Company at Wilmington, Delaware. He has been at the Army Chemical Center, Maryland. His home address will be 45 N. Woodward Ave., Wilmington, Delaware.

Joseph W. Acker, M.E. '52, is a project engineer with Lincoln Electric Co. He is the son of George H. Acker '20 and Evelyn G. Coe Acker '23.

Richard H. Parker, Chem.E. '52, reports that he is finding his work for Atlas Powder Company interesting. On reporting for work, he was assigned to one of the groups at the Central Research Laboratory and, because of unexpected circumstances, was almost immediately put in charge of the experimental unit. He says that the first couple of weeks were a little hectic, but everything is now under control.

Thirteen Cornell alumni serving in Korea have founded the 82nd men's club in the University's alumni association — the Cornell Club of Seoul.

In response to a letter enclosing paper currency for the first year's dues, R. Seldon Brewer, general alumni secretary at Cornell, is sending a permanent charter to the group.

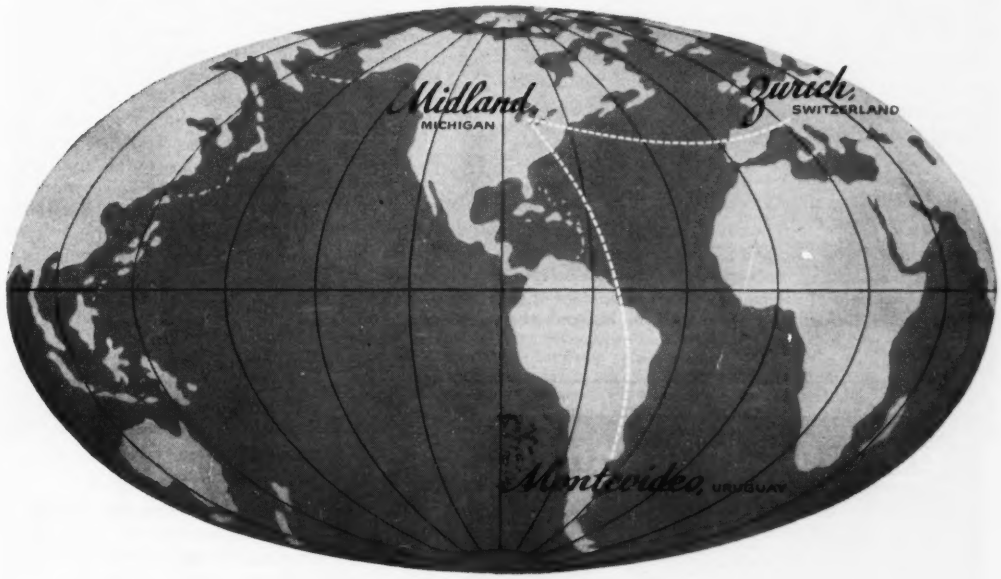
The letter described the club's first meeting as "an elaborate affair in swank Kimchi Joe's Rice Paddy Inn at the 570th Ordnance MAM Company, in suburban Seoul."

Among the thirteen were the following engineers: **Lt. Robert H. Caplan III, Chem.E. '51; Lt. Walter S. Crone, M.E. '51; Lt. Donald P. Victorin, Chem.E. '51; Lt. Sanford H. Taylor, Chem.E. '51; Lt. James A. Meyler, M.E. '51; Lt. Edward B. Magee Jr., M.E. '51; Lt. James C. Huntington Jr., E.E. '50; Lt. Phillip C. McMaster, Admin.E. '49; and Lt. Col. Alfred L. Stevens, M.E. '33.**

DOW

DOW ADDS NEW EXPORT COMPANIES

Dow has recently formed two subsidiary export companies to serve foreign industry's increasing demands for high-quality chemicals.



In the Western Hemisphere, Dow Chemical Inter-American Limited with sales offices in Montevideo, Uruguay will supply chemicals to Mexico and to many countries in Central and South America.

Industries in other continents—Europe, Asia, Africa, and Australia—will be served by Dow Chemical International Limited. Its first sales office will be in Zurich, Switzerland.

These two new export companies are only one example of the continued growth taking place at Dow. Each year finds new Dow plant facilities, increased production, new products developed . . . an over-all growth and expansion that requires a steady influx of men of varying talents, as well as providing excellent opportunities for those within the Dow organization.

Dow's Booklet, "Opportunities with The Dow Chemical Company," especially written for those about to enter the chemical profession, is available free, upon request. Write to The Dow Chemical Company, Technical Employment, Midland, Michigan.

you can depend on DOW CHEMICALS DOW

William G. Christy, M.E., '11, appointed in 1950 as Director, Bureau of Smoke Control and Chairman, Smoke Control Board, New York City, announces severance of that connection and opening his office as consulting engineer, 34 Park Row. He specializes in air-pollution control, combustion, fuel and refuse burning, and smoke control.

Thomas S. McEwan, '11, has been appointed a Vice-President of Lester B. Knight & Associates, Inc. Mr. McEwan formerly was Resident Manager Engineer of Stevenson, Jordan & Harrison, Vice-President of McClure, Hadden & Ortman, Inc. and a partner in Wolf Management Engineering Co. In 1941-1942 he served in Chicago as First Regional Director of the War Production Board.

Hubert H. Race, E.E., '22, '27, a native of Buffalo, is an engineer active in the field of atomic power. He attended Cornell, receiving a bachelor's degree in 1922 and a doctorate in electrical engineering in 1927. After two years as an assistant professor here, he joined the General Electric Company's physical research staff in 1929. GE selected him to plan and organize its atomic energy research laboratory and the Knolls atomic power laboratory built and operated for the Atomic Energy Commission by GE. He is now in GE's management consultant services division in New York City, a member of the board of directors of the Schenectady Chamber of Commerce, and has served for six years on the education committee of the U.S. Chamber of Commerce.

Harry W. Robb, E.E. '23, A.B. '24, former assistant manager of standards at General Electric Co., was made manager of the company's standard services department, January 9. Besides his work on the development of their Standards Book, he has served as chairman of several committees of the American Standards Association and headed the American delegation which went to London in 1951 to conclude the development of commercial standards for three countries. Also in 1951, he spent nine months in Washington as director of engineering materials and methods on the production controls staff of the National Production Authority.

George A. Porter, M.E. '25, has been advanced to vice-president in charge of engineering, construction, and operations at the Detroit Edison Company. He started with the company in 1925 in its research department. He was transferred to the construction department and later became assistant superintendent at the Delray Power Plant. In 1947 he was made assistant chief engineer of power plants. In 1949 he became chief engineer of power plants and on January 1, 1952, manager of construction.

Erik B. J. Roos, M.E. '32, has become an associate of Seelye, Stevenson, Value, and Knecht and has general charge of mechanical and electrical engineering.

Hugh E. Weatherlow, C.E. '06, retired superintendent of buildings and grounds at Cornell, has received a life membership in the American Society of Civil Engineers from the national organization.

After graduating from Cornell, Mr. Weatherlow spent 30 years in the construction business in New York and Florida. He returned to the University in 1936 as superintendent of buildings and grounds and retired in June, 1950. He and Mrs. Weatherlow live at 403 Elmwood Ave.

Harold W. Slauson, M.E. '07, now living on West Lake Road, Skaneateles, has received a "Gold Seal Certificate" representing continuous membership in the Society of Automotive Engineers for more than thirty-five years. Slauson joined the Society soon after its organization in 1909, and was thereafter chairman of its New York City section and one of the national committees.

● ALBANENE,* a K&E product, is the preferred tracing paper in thousands of drafting rooms. It is transparentized, not with messy oils that leak, but with a special synthetic transparentizer developed by K&E. ALBANENE does not turn brittle or lose its transparency with time. After years it is as good as new. *Trade Mark®

KEUFFEL & ESSER CO.

EST. 1867

NEW YORK • HOBOKEN, N. J.

Chicago • St. Louis • Detroit • San Francisco • Los Angeles • Montreal

K+E

Drafting, Reproduction and Surveying Equipment and Materials; Slide Rules, Measuring Tapes.

500 SHAKES PER SECOND. This Sperry engineer closely observes the performance of a Gyropilot* flight control system being vibration tested at 500 cycles per second on a shake table. All Sperry equipments are being constantly "tortured" and exposed to conditions more rigorous than they will undergo even in tomorrow's aircraft.

Things are on the move at Sperry

...WITH EXCELLENT OPENINGS AND TOP SALARIES FOR GRADUATE ENGINEERS!

How would you like to start right in working with leaders? . . . That's what *you* can do at Sperry.

You enjoy good pay as you keep on learning—in research, product development, or field work. You'll be expected to use originality and a fresh approach to every problem. And as a member of the Sperry engineering staff, you'll have continuing creative challenge.

CHOICE OPENINGS FROM WHICH TO CHOOSE

Diversity is the word . . . openings for aeronautical, electrical, electronic, mechanical engineers—physicists—technical writers and field engineers for applied engineering.

ATTRACTIVE LOCATIONS

Long Island—A pleasant suburban atmosphere convenient to New York. Modern plant. Well-equipped laboratories. Excellent working facilities.

In the Field—There are excellent applied engineering opportunities in various sections of the United States and abroad.

GOOD WORKING CONDITIONS

The way is clear for steady advancement. You are encouraged to continue your education while you earn. And liberal employee benefits are provided for all.

AHEAD FOR FORTY YEARS!

Sperry research leadership has led the industry for more than a generation. Today Sperry is the recognized leader in developing automatic controls for navigation. From Sperry's work in gyroscopics and electronics have come the Gyropilot* flight controller, Zero Reader* flight director, radar, servomechanisms, computing mechanisms and communications equipment.

CHECK YOUR PLACEMENT OFFICE FOR DATES WHEN SPERRY REPRESENTATIVES WILL VISIT YOUR SCHOOL . . . OR WRITE SPERRY EMPLOYMENT SECTION 1A5.

*T. M. REG. U. S. PAT. OFF.

SPERRY GYROSCOPE COMPANY
DIVISION OF THE SPERRY CORPORATION

GREAT NECK, NEW YORK • CLEVELAND • NEW ORLEANS • BROOKLYN • LOS ANGELES • SAN FRANCISCO • SEATTLE
IN CANADA • SPERRY GYROSCOPE COMPANY OF CANADA LIMITED, MONTREAL, QUEBEC

Soil Testing —

Yardstick For Construction

By M. D. MORRIS, C.E. '44
and JOHN P. GNAEDINGER, M.C.E. '46

Illustrations Courtesy Soil Testing Service, Inc.

Soil as engineering material is comprised of mineral grains, dissolved salts, water and air. Soils differ in identity primarily in the nature of the mineral grains and dissolved salts, since the water and air are for all practical purposes uniform in nature in all soils.

A soil is generally identified in terms of grain size characteristics, color, mineral content and properties of the mineral grains. Occasionally, the origin of a soil is included in the identification, however, the identification of a soil usually does not reflect quantitatively its probable behavior under exterior forces.

Single Story Plant Structures

Every-day foundation problems involved in the design of one-story plant type construction are the bearing capacity of the spread footings, the probable settlement of the completed structure, and the placing of compacted fill and removal of top soil to prevent cracking of the floor slab.

For structures of this type, soil borings of the split spoon and Shelby tube method are generally employed. Borings should be carried not less than ten or fifteen feet below the bottom of the proposed footings. Unless soft material is encountered above that depth, the effect of soft strata underlying that depth is usually of little consequence unless the area of the structure is covered by a fill of considerable depth.

The bearing capacity used in the design of spread footings, if very tough or hard clays, silts, or sands are encountered, can be determined with reasonable accuracy by the use of the bearing capacity relationship established by Dr. Carl Terzaghi.

In the event that soft or stiff clays, organic matter, or loose silts are encountered, tests should be performed to determine the compressibility of the material. The column loads should be supported on piles or caissons carried to a deeper strata of greater strength.

If the area of the plant is covered by top soil of some thickess, and if the floor loads exceeded several hundred pounds per square foot, it is generally desirable to remove the top soil and replace with a granular fill or a compacted clay fill, as top soil will compress considerably under relatively small loads.

Generally the construction problems involved in the factory type structure are reasonably small, as excavations generally are not deep. Usually in North America footings are carried below the frost line and no deeper. Wherever footings must go below the ground water table the effect of the water in causing quicksand and in softening clay strata must be considered.

Multi-Story Buildings

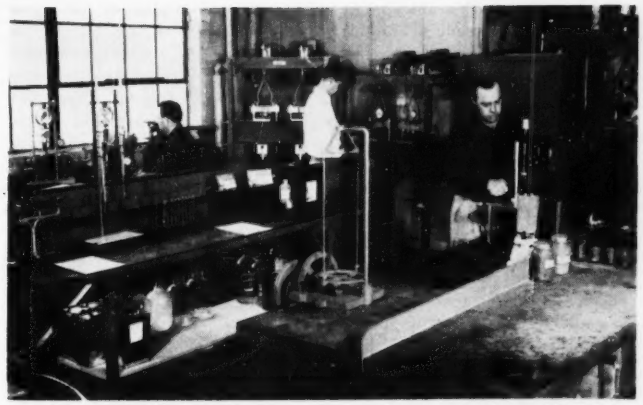
Difficulties posed by the design of foundations for multi-story building are similar in many respects to those just mentioned for plant type structure. Here, however, the load per square foot caused by the structure usually becomes large enough so that possible consolidation of underlying strata must be considered much more carefully than for the one-story structure. For this reason, information must be obtained on the nature and extent of soil strata for depths not less than one and a half times the lesser dimension of the building. Thus, a 22-story apartment building, with dimensions of 40′ by 100′, will exert pressures of perhaps 2500 lbs. per sq. ft. average under the entire area of the structure. Generally, if no soft strata are encountered within an approximate depth of 60′ beneath the footing elevation, little danger of consolidation settlements exists. However, if soft underlying strata are reached (even though the soil at the footing elevation is dense or hard), the effect of the weight of the structure on consolidation settlements of the underlying soft strata must be con-

ABOUT MR. MORRIS

M. D. Morris was born in New York City in February of 1922. He attended Stuyvesant High School there and following graduation, enrolled in the School of Civil Engineering at Cornell. While at Cornell he was active in A. S. C. E. and participated in varsity boxing and football. During his undergraduate years he was the holder of a McMullen War Scholarship.

Mr. Morris' professional career began with the Curtis-Wright Corp. in Buffalo, N. Y. After serving with the Army Corps of Engineers during World War II, he held positions with the Department of Public Works and Sanitation of New York City, and the Venezuelan Institute of Sanitary Works. While in Venezuela, he served as head of engineering in purchasing.

Mr. Morris is presently a member of A. S. C. E., and S. A. M. E., and writes regularly for the trade journals in his field. Although he is now associated with the Engineering group of Bechtel International Corp. working on the Orinoco Mining Project, he still finds time to collaborate with Mr. Gnaedinger on projects for Soil Testing Services.



Soil testing laboratory with equipment for unconfined compression, triaxial, and consolidation tests.

sidered. And if these probable settlements are excessive, piles or caissons must be used to transmit the column loads to denser or harder substrata.

When a basement constructed in a multi-story building involves the removal of some of the soil at the site, the pressure exerted by the soil is actually removed from the underlying compressible strata. The weight of the excavation can be deducted from the weight of the structure in calculating pressures which will tend to cause compression of the soft substrata. If the weight of the soil removed is equal to the weight of the structure, then no danger of consolidation will exist. This, of course, assumes a fairly fast construction schedule, as rebound in the underlying clay might become significant if the time between the original excavation and the placing of the foundations is great.

Residences

Inasmuch as the average residence today cost somewhere between $10,000 and 20,000, owners are not generally willing to spend much of this on a thorough foundation investigation. Furthermore, such extensive investigations are not generally warranted by the demands of the load on the foundations. For these reasons, it is usually suitable to perform several auger borings to obtain general information on the soil types at the site.

If really soft materials are encountered, it may be cheaper to purchase another site than to provide special foundation types, or to carry them to great depths. However, where soft materials are encountered, and construction must proceed at the site, it is sometimes necessary to perform a more thorough subsurface investigation before an adequate design of the foundation can be established.

The principal advantage of preliminary foundation investigations for residences is the determination of the ground water level. This information is particularly useful in determining what precautions must be taken against water in a basement, and in determining, if any, what capacity sump pump is required.

Highways and Airports

In the design of highways and airport pavements the primary problem involved is to provide a sub-base or a subgrade for the pavement which will support the pavement under the superimposed loads during all seasons and under all conditions of moisture content. The choice of flexible or rigid type pavements creates additional special problems. Before a pavement is designed, the subgrade material is generally sampled to depths of several feet below the proposed grade. If this material is found to be highly plastic in temperate climates, trouble can generally be expected due to frost action, swelling, and pumping under conditions of excess moisture. Any one of the three phenomena can cause the destruction of the pavement.

Usually, if unsuitable materials are found in the subgrade, it is necessary either to replace them with granular fill, or to superimpose on top of the natural material a sub-base of adequate strength to support the pavement and the maximum designed live load. In areas where complete saturation exists, sand drains may be used.

Methods used to determine the necessary thickness of sub-base and pavement have been developed by a number of different organizations. Among those most useful are the California Bearing Ratio method, the triaxial compression test method, the plate bearing test method, and various combinations of the three. In most cases ultimately the most successful mode for the design of pavements will be the use of triaxial compression and classification tests for determining the initial design, the performance of plate bearing tests in the field to establish the final design, and the use of the California bearing ratio method as a field control test to insure that all portions of the pavement will be underlaid by suitable sub-grade.

Dams

The problems of structural stab-

Caisson underpinning operations for a settling building.

ility and probable settlements are perhaps of greater importance in the building of dams than they are in the construction of buildings. Generally the risks involved are much greater, especially with regard to the loss of lives, in the event of failure. This is why foundation investigations for dams are usually extensive, and generally include considerable testing to determine all the physical properties of the soil. In addition to these, the permeability of the soil must be considered at the dam site. Should the dam not hold water, its purpose is lost. Extensive loss of water can also endanger the safety of the structure under circumstances where the flow of water removes soil from beneath the dam.

Bridges

In Part I brief mention was made about the value of soils analyses at bridge sites to determine pH values and their effect on steel sheeting or piling that may be driven there. Now our primary concern is the effect of settlement on the stability of bridges. Excessive settlements in one or all piers might create stresses in the structure for which the bridges were not designed. These stresses might result in cracking and possible failure of the structure.

Generally borings are made at each pier site and laboratory tests performed to determine if special provisions must be made to support the piers. The additional problem of possible undercutting usually indicates that caissons or piles are best suited for the foundation in those cases.

Although rather general, the aforegoing discussions show the manner and extent to which an engineer may forearm himself before attempting a structural design. Further detailed information may be obtained from any of the references mentioned earlier or in one of a hundred authoritative books of which *Fundamentals of Soil Mechanics* by D. W. Taylor or *Soil Mechanics and Laboratory Practice* by R. Dawson are typical examples. Soil mechanics is truly an economical yardstick for construction because there is no substitute for the efficient manner in which an engineer can work when he has all the pertinent data on hand at the outset.

Reprinted by courtesy of Ingenieria Internacional Construccion.

I was at the films the other day. Onto the screen strode a burly, bronzed, six-foot-three figure of a man replete in jack boots and duffel coat. He listened to a man behind an office desk who said: "This is difficult and dangerous work; the prospects of success are remote; they mean hard work, the will to pull through against all obstacles. You have a free hand to do what you like as long as you succeed. Will you take it?" And the burly, bronzed, six-foot-three-er replied, "Sure — that's what we engineers like." My wife went off into a peal of laughter.

Now women have a way of judging people accurately without being able to produce a nice, tidy, logical proof of their reasoning. So I began to meditate. It soon became apparent that someone in Hollywood had made a mistake.

On the whole I cannot say that many engineers of my acquaintance have been tall, nor bronzed, nor have any at all expressed a liking for a dangerous job.

Whenever I attend an engineering meeting I always at first circulate on the fringe of the gathering trying to observe from the outside what engineers as a bunch look like. They never strike me as being a very impressive lot at a first glance. In fact, I have to admit reluctantly, until otherwise convinced, that there is a singular lack of evidence in an engineering meeting that these are tough, down-to-earth, practical men. I faintly wish that some of my colleagues would have the temerity to turn up in leathered-soled gunboats and duffel coats, or at least in tweeds and heavy brogues. But no! I have to avert my eyes from slick gentlemen in pin stripes and thin-soled black shoes, to finally pick out a gentleman in a brown suit, who with his sharp gaze and untidy hair seems to have blown in straight from some massive engineering operation.

Alas, this gentleman turns out to be the magic lantern operator.

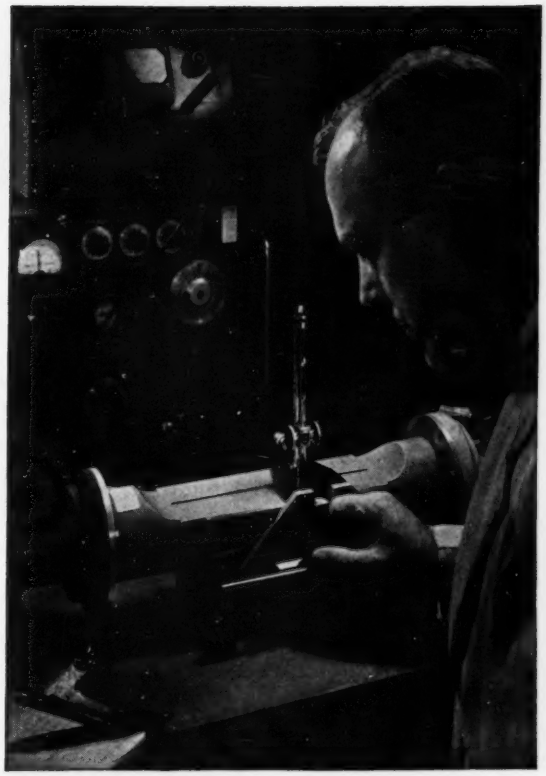
Of course there are exceptions. There was Mr. A., for instance, who could stride up to the blackboard and disprove all previous theories by lightning use of calculus. And there was Mr. B., too, whose pockets could always be relied upon to disgorge some samples of engineering interest. These men were engineers!

Come let us rally to the Hollywood idea (myth though it may be) and deck ourselves in duffel coats and boots, and if anyone can put me onto a place where they sell duffel coats for a 26-inch waist and 5-0 height, and size 5 boots, I shall play my part, even if it be in miniature.

—lifted from the *Journal of the Engineering Societies of New England*, which lifted above essay from *Water and Water Engineering*, April, 1952.

Build your future with Bendix

AVIATION CORPORATION



JOIN AMERICA'S LEADING TEAM OF CREATIVE ENGINEERS!

Your opportunity is as big as you want to make it in Mechanical Engineering • Hydraulic Mechanisms • Electronics • Magnetics • Computers • Servo-mechanisms • Radar Research • Metallurgy • Solid-State Physics • Instrumentation • Radiation Detection • Nuclear Physics • Guidance and Control Systems plus many more engineering fields.

You'll find Bendix has much to offer the young graduate engineer of today. It's only natural since the Bendix Aviation Corporation is primarily a *creative engineering* and manufacturing organization—unlike any other in America in its versatility, facilities, experience and range of products. And of real importance to you is the fact that this firm is engineering-minded from top management down. Currently, Bendix engineers—an average of 1 out of 18 employees as compared to the all-industry average of 1 out of 50 employees—are building important careers for themselves in design, development, research, production supervision and sales. Many of these men come from schools such as yours. Whatever engineering field you've trained for, and wherever your interests lie in that field, you'll find positions at Bendix that provide the answer you've been looking for. Plan now to build your future with Bendix!

BENDIX AVIATION CORPORATION
Executive Offices: Fisher Building, Detroit 2, Michigan
DIVISIONS, PRINCIPAL SUBSIDIARIES AND AFFILIATED COMPANIES

Bendix Products Division, South Bend, Indiana
Hamilton Division, Hamilton, Ohio
Bendix Radio Division, Towson, Maryland
Eclipse-Pioneer Division, Teterboro, New Jersey
Bendix-Westinghouse Automotive Air Brake Company, Elyria, Ohio
Utica Division, Utica, New York
Bendix Computer Division, Hawthorne, California
Eclipse Machine Division, Elmira, New York
Friez Instrument Division, Towson, Maryland
Marshall-Eclipse Division, Troy, New York
Pacific Division, North Hollywood, California
Red Bank Division, Red Bank, New Jersey
Skinner Purifiers Division, Detroit, Michigan
Cincinnati Division, Cincinnati, Ohio
Scintilla Magneto Division, Sidney, New York
Zenith Carburetor Division, Detroit, Michigan
Kansas City Division, Kansas City, Missouri
York Division, York, Pennsylvania
Bendix Aviation Research Laboratories, Detroit, Michigan
Pioneer-Central Division, Davenport, Iowa

Nation-wide Network of Plants and Laboratories Enables You to Choose Your Location

Bendix operations and activities are distributed among 13 laboratories and 22 manufacturing centers. Each functions independently with its own engineering staff. As a result, you enjoy a small company atmosphere but benefit from the facilities of a large organization. Last year, Bendix spent over $50,000,000 for engineering alone. For sure, ideas are not cramped at Bendix!

For complete information on a Bendix engineering career, have your placement office arrange an interview for you with the Bendix Representative who will be at your campus soon. Or write to:

Bendix
AVIATION CORPORATION
FISHER BUILDING
DETROIT 2, MICHIGAN

Bendix Products Are Used in These Industries and Services

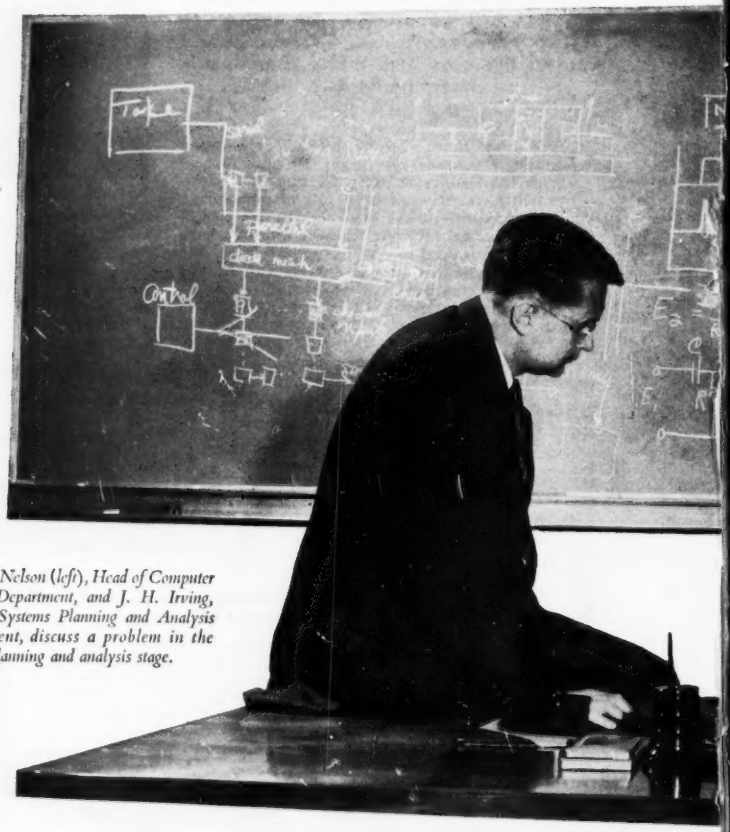
Agriculture	Electronics	Marine	Public Service
Automotive	Atomic Energy	Metals	Railroad
Aviation	Lumber	Petroleum	Textile
	Construction		

PLANNING THE RIGHT ANSWERS

The complexity of modern air defense—extreme aircraft speeds, highly complex weapons, new combat strategies, the advanced state of today's technology—poses serious problems for the scientist and engineer.

One significant solution lies in the extensive use of airborne automatic equipment, including electronic digital computers, to augment or replace the human element in aircraft control.

At Hughes Research and Development Laboratories



Dr. E. C. Nelson (left), Head of Computer Systems Department, and J. H. Irving, Head of Systems Planning and Analysis Department, discuss a problem in the systems planning and analysis stage.

each problem is attacked basically, beginning with systems planning and analysis. This consists of an exhaustive examination of the requirements of a problem, together with an evaluation of the best means for satisfying these requirements. The objective is to design the simplest possible mechanization consistent with a superior performance.

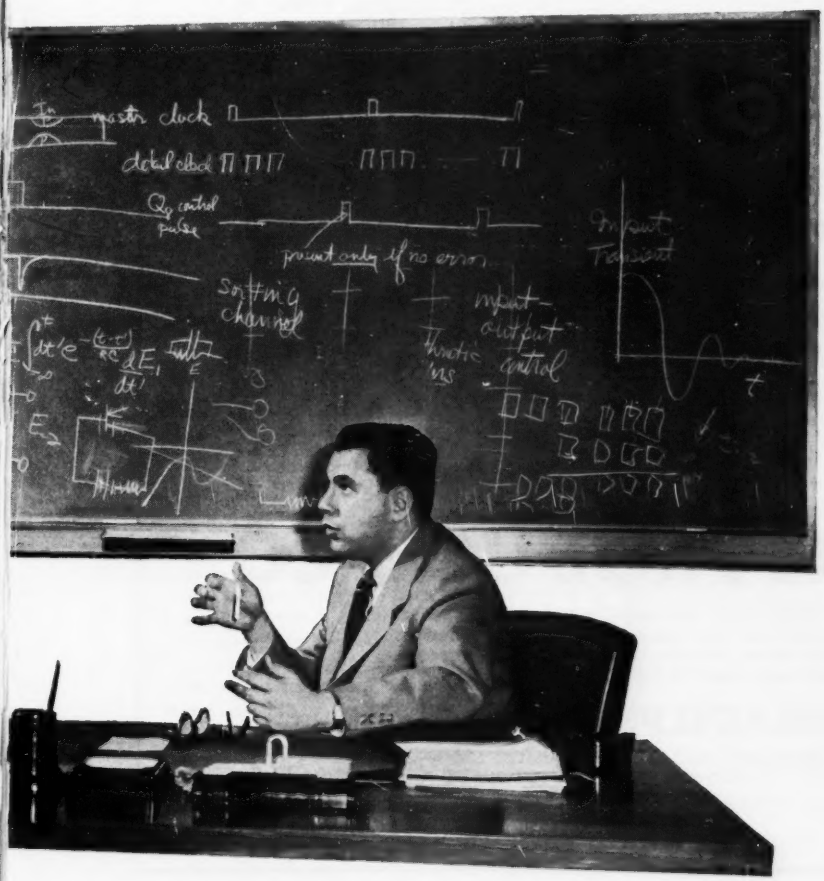
These techniques, employing many special talents, are responsible at Hughes for the successful design, development *and* production of complexly interacting automatic systems for all phases of electronic control of interceptor navigation, flight control, and fire control. Similiar accomplishments may be pointed to in the guided missile field.

Methods of systems planning and analysis responsible for achievements in the military area are also being applied at Hughes to adapt electronic digital computer techniques for business data processing and industrial controls.

HUGHES

Research and Development Laboratories

CULVER CITY,
LOS ANGELES COUNTY,
CALIFORNIA



PHYSICISTS AND ENGINEERS

Hughes activities in the computer field are creating some new positions in the Systems Planning and Analysis Department. Experience in the design and application of electronic digital computers is desirable, but not essential. Analytically inclined physicists and engineers with a background in systems work are invited to apply.

ADDRESS:
SCIENTIFIC
AND ENGINEERING
STAFF

Have you considered the advantages of working in a small company?*

MEN OF '53

Your placement officer has information on the Moore Products Co., its accomplishments, and its training program.

Every Cornell man who has entered the training program is still with the company:

Thomas W. Clements ('48), Manager, Methods Engineering Dept.

Edwin G. Rorke, Jr. ('48), Manager, Panel Dept.

Whitney B. Miller ('49), Manager, Louisville Branch Office

John E. Royer ('50), Sales Engineer, Detroit Branch Office

RECENT GRADUATES

Plans for expansion make immediate opportunities in the Engineering and Sales Departments. Write to D. B. Kirk, Chief Engineer, or C. H. Thompson, Sales Manager.

* *220 employees*

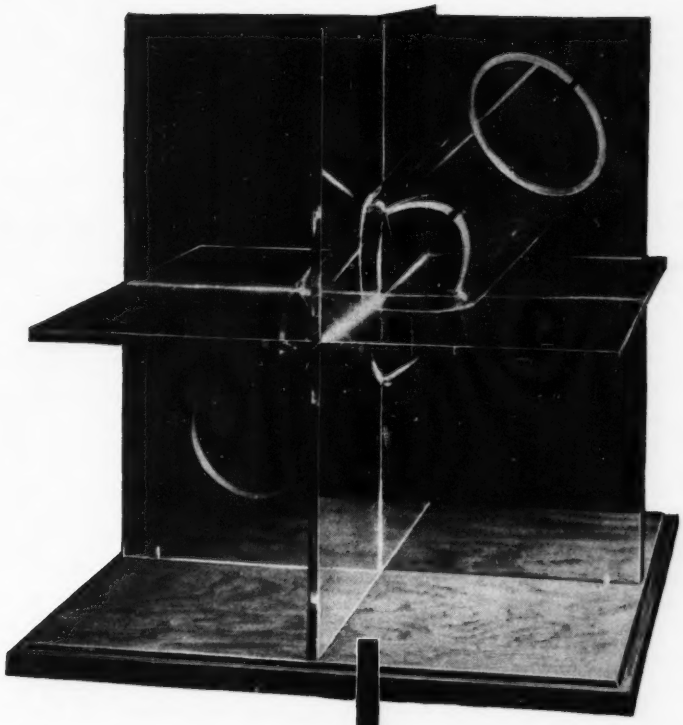
MOORE PRODUCTS CO.

Manufacturers of *NULLMATIC Industrial Instruments* for measurement and control in the process industries and of *Moore Pneumatic Comparator Gages* for dimensional measurement in high-production manufacturing.

PHILADELPHIA 24, PA.

Branch Offices: CHICAGO, DETROIT, HOUSTON, LOS ANGELES, LOUISVILLE, NEW YORK, PITTSBURGH

In Canada: Moore Instrument Co., Ltd., TORONTO



A Bearing Theory with a bearing on your job future

The futuristic-looking object in the picture above is a demonstration model of Maxwell's distortion energy theory concerning the yielding of ductile materials.

And it's used by our General Motors research engineers in their study of "bearing fatigue."

From this study they have succeeded in discovering new facts about the "thick and thin" of bearing surface metals—and thus added to wearing qualities of journal and engine bearings.

We publish it here to point up a fact that should not be overlooked by the engineering student with a bent for research.

That fact is the wealth of opportunity for the research-minded engineer to function creatively at General Motors.

Yet research engineering is only one of the opportunities at General Motors for the graduate engineer.

For GM is not only a leading producer of motor-cars and trucks. It also manufactures many other types of civilian goods from heating and air conditioning systems to refrigerators, from fractional h.p. motors to Diesel locomotives.

And, as a top defense contractor, GM builds everything from rockets and range finders to jet and Turbo-Prop airplane engines.

So there's plenty to work on at GM. And plenty of engineering brains to work with.

Our many graduate engineers in top management prove that the engineer with the ability to make real use of what GM has to offer can build himself a very satisfying future in the GM family.

So why not ask your College Placement Office to arrange an interview for you with the GM College Representative the next time he visits your campus? Or drop us a line.

GM Positions now available in these fields:

MECHANICAL ENGINEERING • ELECTRICAL ENGINEERING
METALLURGICAL ENGINEERING • INDUSTRIAL ENGINEERING
CHEMICAL ENGINEERING

GENERAL MOTORS

Personnel Staff,
Detroit 2, Michigan

Letters To The Editor

To the Editor:

Re: November Brain Teaser.

In the January issue a solution to the November Brain Teaser appears which has one detail missing. One of Green's brothers-in-law is superior in rank. Therefore, not only does this prevent Green from being the general, but it also prevents him from being the colonel, as the general is not the colonel's or Green's brother-in-law.

About four or five of us worked on this problem, and two got the answer listed in the book while the others determined the following to be the correct answer:

	Name	*Wife's Maiden Name*	*Sister's Husband*
General	Smith	White	Jones
Colonel	Brown	Jones	Green
Major	White	Green	Smith
Captain	Green	Brown	White
Lieutenant	Jones	Smith	Brown

If we line the men up in order of marriage using a symbol for each we find that there is a pattern they must follow. The fastest and easiest way to solve this problem is to set it up graphically using the following facts:

1—As two men have not served in France, one brother-in-law of each Jones and White must be the same man (in this case the general).

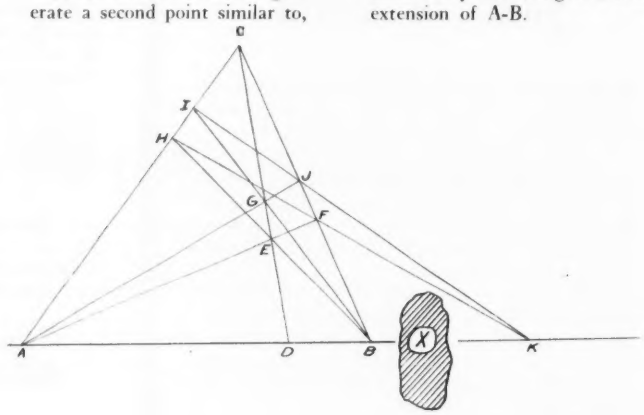
2—As White's wife's brother served in Japan this must be the other brother-in-law from the general.

Using this type of logic and graphic representation only two answers were found to fit the direct facts, namely, the one listed here and the one listed in the January issue. Further elimination found that Green must be the captain to get at least one brother-in-law superior in rank to him.

CLAUDE G. WALL, Chem.E. '42
Philadelphia, Penn.

Answer To Last Month's Brain Teaser

1. To A-B draw any two lines A-C and B-C meeting at point C.
2. From C draw a line C-D terminating on A-B. Note that it must be on that side of a vertical from C to A-B nearer X.
3. Draw any line B-H crossing C-D at point E.
4. Start a line A-F at A and pass it through point E on C-D to terminate on C-B at F.
5. Join H and F to produce line H-F-K.
6. Repeat steps (3) and (4) to produce A-G-J and B-G-I as shown.
7. Join and extend I and J to produce I-J-K. The intersection of H-F-K and I-J-K at K will lie on the extension of A-B.
8. Make a similar construction on the other side of line A-B to generate a second point similar to, but removed from K. Joining these two points will give a true extension of A-B.



Do you own everything you would like?

If not, perhaps the problem of worker lay-offs could be solved

EVERY MAN, woman and child in America knows of many things he would buy if he could afford them—that is, if the price were low enough. Cutting prices to the point retailers and manufacturers lose money and go bankrupt is no answer. Cutting *costs* is.

Suppose every producer (mine, farm, factory) equipped itself with the most modern productive equipment—and fair tax laws let them save enough to pay for that equipment. Then let every worker use that equipment at maximum efficiency.

Costs would tumble.

Then let business pass those savings on to the public.

Prices would tumble.

Finally, suppose the consumer did his part, and bought. There would be such business as the world never dreamed of. More store clerks would be needed to handle the demand, more transportation workers to haul the goods, more workers to produce them. The more demand and production, the lower the costs and prices; the lower the costs and prices, the more the demand and production. And everyone would have more and more of the things he wants.

Why isn't it done? Greed, fear, misunderstanding.

Honesty, hard work, unselfishness would do it, for the principle has been proven a thousand times. We've tried laws, contracts, strikes, slowdowns—and all we've got is hatreds, shortages, and periodic lay-offs. Is there a leader great enough to rally all America to put this *positive* approach to work? The approach that every honest man knows in his heart is *right.*

There are employment opportunities at Warner & Swasey for young men of ability and character who believe as firmly in the principles of Americanism as they do in the principles of sound engineering. Write Charles Ufford.

YOU CAN PRODUCE IT BETTER, FASTER, FOR LESS WITH WARNER & SWASEY MACHINE TOOLS, TEXTILE MACHINERY, CONSTRUCTION MACHINERY

Promise of a golden future

Yellow uranium ore from the Colorado Plateau is helping to bring atomic wonders to you

Long ago, Indian braves made their war paint from the colorful sandstones of the Colorado Plateau.

THEY USED URANIUM—Their brilliant yellows came from carnotite, the important uranium-bearing mineral. Early in this century, this ore supplied radium for the famous scientists, Marie and Pierre Curie, and later vanadium for special alloys and steels.

Today, this Plateau—stretching over parts of Colorado, Utah, New Mexico, and Arizona—is our chief domestic source of uranium. Here, new communities thrive; jeeps and airplanes replace the burro; Geiger counters supplant the divining rod and miner's hunch.

From hundreds of mines that are often just small tunnels in the hills, carnotite is hauled to processing mills. After the vanadium is extracted, the uranium, concentrated in the form of "yellow-cake," is shipped to atomic energy plants.

A NEW ERA BECKONS—What does atomic energy promise for you? Already radioactive isotopes are working wonders in medicine, industry, and agriculture. In atomic energy, scientists also see a vision of unknown power—which someday may heat and light your home, and propel submarines, ships, and aircraft. The Indian's war paint is on the march again—toward a golden future.

UCC TAKES AN IMPORTANT PART—The people of Union Carbide locate, mine, and refine uranium ore. They also operate for the Government the huge atomic materials plants at Oak Ridge, Tenn., and Paducah, Ky., and the Oak Ridge National Laboratory, where radioisotopes are made.

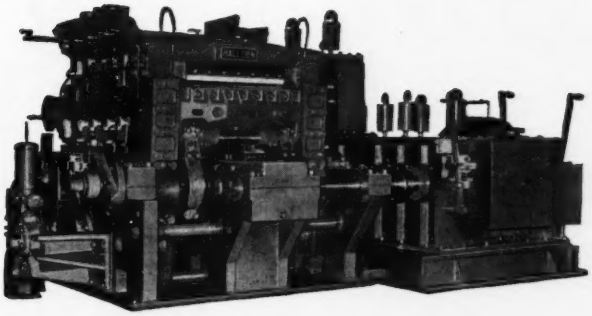
STUDENTS and STUDENT ADVISERS: *Learn more about the many fields in which Union Carbide offers career opportunities. Write for the free illustrated booklet "Products and Processes" which describes the various activities of UCC in the fields of* ALLOYS, CARBONS, CHEMICALS, GASES, *and Plastics. Ask for booklet B-2.*

UNION CARBIDE
AND CARBON CORPORATION
30 EAST 42ND STREET UCC NEW YORK 17, N. Y.

UCC's Trade-marked Products of Alloys, Carbons, Chemicals, Gases, and Plastics include

ELECTROMET Alloys and Metals • HAYNES STELLITE Alloys • EVEREADY Flashlights and Batteries • NATIONAL Carbons
ACHESON Electrodes • PYROFAX Gas • PRESTONE and TREK Anti-Freezes • PREST-O-LITE Acetylene
BAKELITE, KRENE, and VINYLITE Plastics • DYNEL TEXTILE FIBERS • LINDE Oxygen • SYNTHETIC ORGANIC CHEMICALS

Another page for **YOUR BEARING NOTEBOOK**

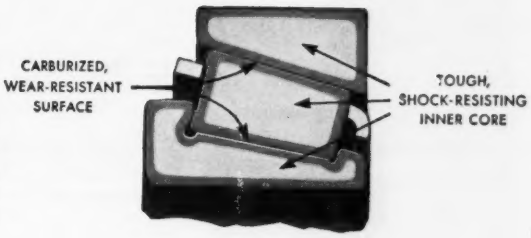


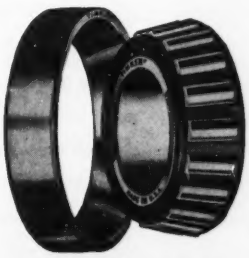
Guillotine shear cuts cost of cutting steel

To carry the terrific shock loads imposed on pinions and gears in this flying shear, engineers mount them on Timken® tapered roller bearings. Maintenance and repair costs are cut, costly breakdowns prevented, accuracy insured. Because of their tapered construction, Timken bearings take radial and thrust loads in any combination. They minimize friction, reduce wear — normally last the life of the machine.

Why TIMKEN® bearings can take the toughest loads

In Timken bearings, the load is carried on a line of contact between the rollers and races instead of being concentrated at a single point. Made of Timken fine alloy steel, the rolls and races are case-carburized to give a hard, wear-resistant surface with a tough core to withstand shock.





TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

Want to learn more about bearings?

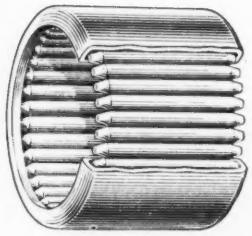
Some of the engineering problems you'll face after graduation will involve bearing applications. If you'd like to learn more about this phase of engineering, we'll be glad to help. Clip this page for future reference, and for a free copy of the 270-page General Information Manual on Timken bearings, write today to The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

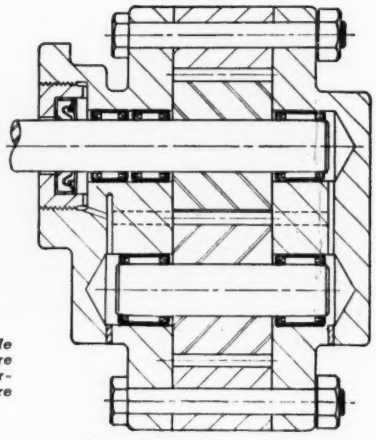
NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL ◐ AND THRUST ⊣◐⊢ LOADS OR ANY COMBINATION ✳

The Torrington Needle Bearing

proper housing design is essential to proper performance

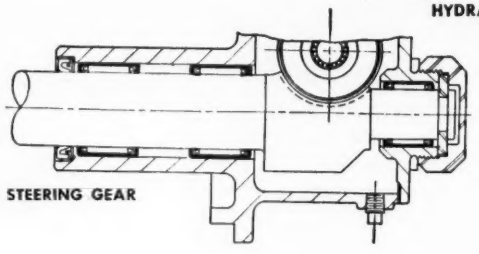
The Torrington Needle Bearing offers many design and operational advantages for a great variety of products and equipment. For example, a Needle Bearing has greater rated radial load capacity in relation to its outside diameter than any other type of anti-friction bearing. It is extremely light in weight. And it is easy to install and lubricate.





HYDRAULIC PUMP

Needle Bearings require simple housings. If the housing bores are held to proper size, accurate operation and high radial capacity are assured.



STEERING GEAR

Housing Maintains Bearing Roundness

The housing is an essential part of the Needle Bearing assembly. Care should be taken to provide a straight, round housing bore to the recommended tolerances.

The thin, surface-hardened outer shell of the Needle Bearing acts as the outer race surface as well as a retainer for the rolls. This shell assumes the shape of the housing into which it is pressed. Consequently, the housing bore should be round, and the housing so designed that it will carry the radial load imposed on the bearing without distortion.

Housing Material Determines Bore Size

The specified housing bore dimensions for any given material should be maintained in order to give the proper running clearance between the needle rollers and the shaft, and to assure sufficient press fit to locate the bearing firmly.

When designing housings of materials that are soft or of low tensile strength, allowance should be made for the plastic flow of the material when the bearing is pressed into place. Bore dimensions in such cases should be less than standard. Needle Bearings can be pressed directly into phenolic or rubber compounds, although metal inserts are recommended.

The new Needle Bearing catalog will be sent on request.

THE TORRINGTON COMPANY

Torrington, Conn. • South Bend 21, Ind.

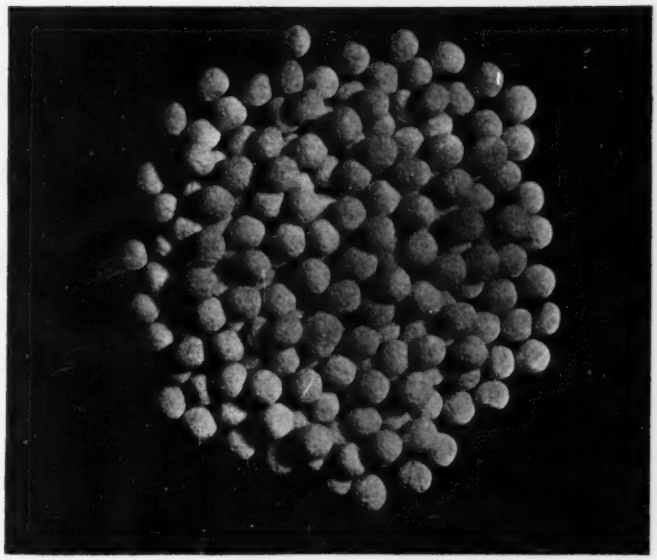
District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON NEEDLE BEARINGS

NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • STRAIGHT ROLLER • BALL • NEEDLE ROLLERS

What Are These Spheres?

- ☐ *Catalyst Supports*
- ☐ *Moth Balls*
- ☐ *Abrasive Grains*



They are catalyst supports — Norton refractory products made of chemically inert, heat-resistant, wear-resistant materials for use as catalytic carriers in chemical processes. Pictured in spherical shape here, they are also available as pellets and rings.

Composition and Properties

These supports are commercially available in ALUNDUM* (fused alpha alumina) mixtures varying from 77% to 89% alumina with silica as the principal impurity. In addition to their refractoriness, they are chemically inert, mechanically strong and wear-resistant.

Water absorption values of these supports vary from 12% to 22% by weight. Surface areas by the nitrogen absorption method range up to about one square meter per gram. Crushing strengths vary from 20 to 600 pounds, depending on size and shape, and bulk densities range from 60 to 80 pounds per cubic foot.

Many Refractory Products

Catalyst supports are but one of many refractory products made by Norton. These include small furnace refractories such as tubes, cores and muffles; large furnace refractories such as bricks, plates, muffles and other shapes; refractory cements; refractory laboratory ware; kiln furniture for ceramic plants.

In its search for refractory products that can be used at higher and higher temperatures, Norton has developed a line of pure oxide refractories. These refractory shapes, as their name implies, are molded without bond and then fired at sufficiently high temperatures to produce a truly sintered product.

The principal raw materials used in the manufacture of Norton pure oxide refractories are ALUNDUM (fused alumina), MAGNORITE* (fused magnesia), fused stabilized ZIRCONIA and, to a limited degree, fused thoria.

Planning Your Future?

Norton Research is continually developing better products to make other products better. Young technicians who are interested in contributing to the technical advances of the future will find Norton Research well worth investigating.

Free Booklet on

longer lasting Norton refractory products contains detailed descriptions of Norton contributions in this field. Write for your copy.

Norma L. Gullberg, A.B., Chemistry, Clark University '46, takes a reading with an optical pyrometer on a high temperature furnace used for catalyst support tests.

*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries

NORTON

TRADE MARK REG. U. S. PAT. OFF.

Making better products to make other products better

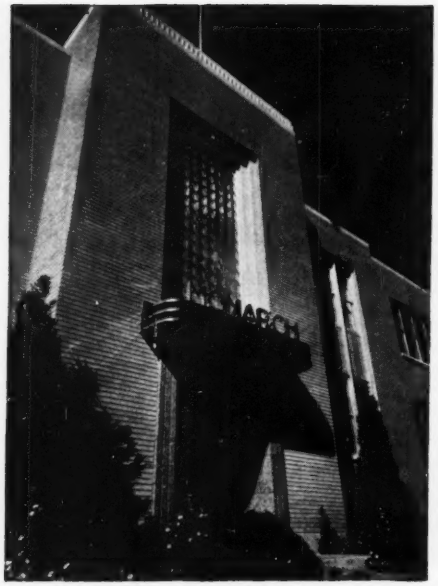
ABRASIVES · GRINDING WHEELS · OILSTONES · ABRASIVE PAPER & CLOTH

REFRACTORIES, POROUS MEDIUMS & LABORATORY WARE · NON-SLIP FLOORING

GRINDING & LAPPING MACHINES · BORON CARBIDE PRODUCTS

NORTON COMPANY, WORCESTER 6, MASSACHUSETTS

BEHR-MANNING, TROY, N. Y. IS A DIVISION OF NORTON COMPANY

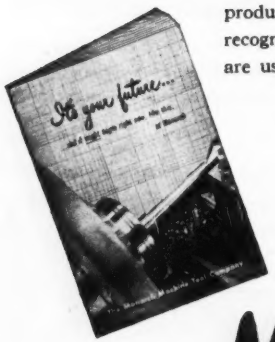


After Graduation— What?

An opportunity exists here at The Monarch Machine Tool Company for several exceptionally well-qualified mechanical, electrical and hydraulic engineering graduates of your class. Mightn't one of these men be you?

The vigorous and vital machine tool industry — keystone of our country's productive power — offers a special satisfaction to its engineers. This is due partly to the basic, sweeping impact of our industry's products; partly because of its continuing program of product development. Inquiry will show you that this is especially true at Monarch, where we specialize in designing and building lathes with a world-wide reputation — with special emphasis on Tracer Control systems for improving accuracy and rate of output.

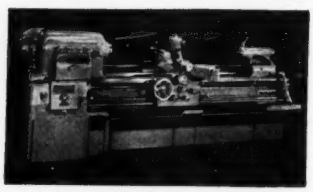
We are in the upper bracket of our industry in size — in the top bracket in product reputation and thus in healthy growth. Engineering talent receives full recognition here. Engineering achievement here makes itself felt wherever lathes are used.



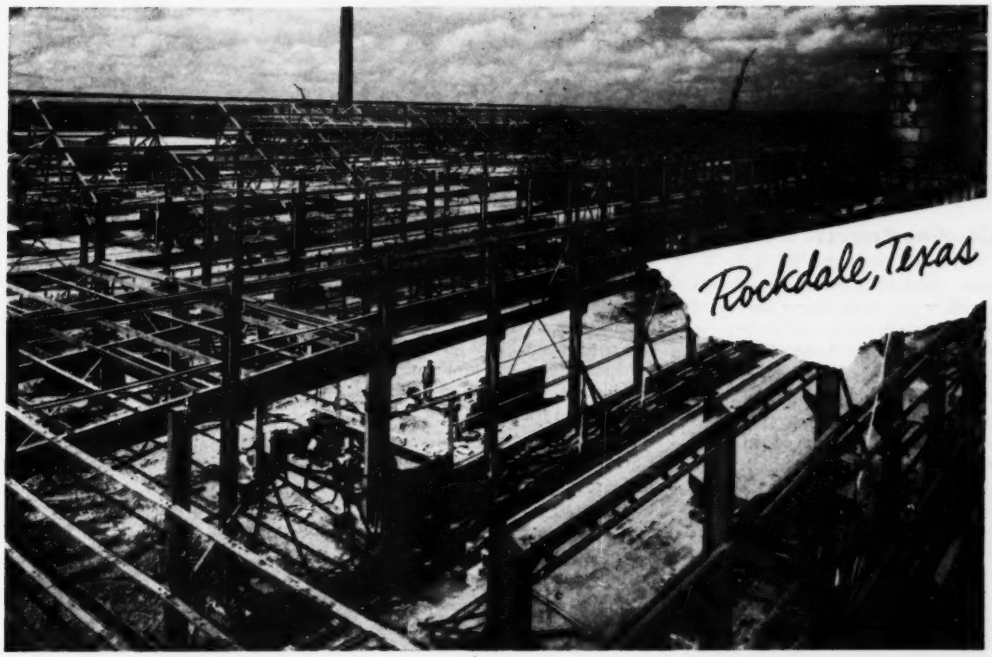
WRITE FOR YOUR FREE COPY OF THIS BOOK!

As we have said, our constant growth means that there will be several openings at Monarch for qualified members of your class. We've prepared this illustrated booklet to give you the Monarch story in more detail than we can do it here. Send for your free copy now. Just address your request to Mr. Kermit Kuck, Vice President — Engineering . . . *The Monarch Machine Tool Company, Sidney, Ohio.*

Monarch
ACCURACY • ECONOMY • LONG LIFE
TURNING MACHINES



FOR A GOOD TURN FASTER . . . TURN TO MONARCH

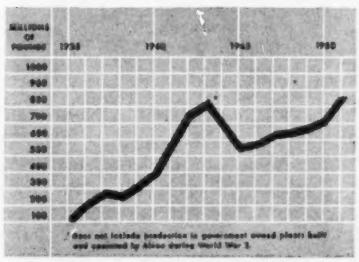


Is part of your future being built here?

Here you see the beginning of another addition to Alcoa's expanding facilities. This plant, at Rockdale, Texas, will be the first in the world to use power generated from lignite fuel and will produce 170 million pounds of aluminum a year. This and other new plants bring Alcoa's production capacity to a billion pounds of aluminum a year, four times as much as we produced in 1939. And still the demand for aluminum products continues to grow. Consider the opportunities for you if you choose to grow with us.

What can this mean as a career for you?

This is a production chart—shows the millions of pounds of aluminum produced by Alcoa each year between 1935 and 1951. Good men did good work to create this record. You can work with these same men, learn from them and qualify yourself for continually developing opportunities. And that production curve is still rising, we're still expanding, and opportunities for young men joining us now are almost limitless.



Ever-expanding Alcoa needs engineers, metallurgists, and technically minded "laymen" for production, research and sales positions. If you graduate soon, if you want to be with a dynamic company that's "going places," get in touch with us. Benefits are many; stability is a matter of proud record; *opportunities are unlimited.*

For more facts, consult your Placement Director.

Alcoa Aluminum

ALUMINUM COMPANY OF AMERICA

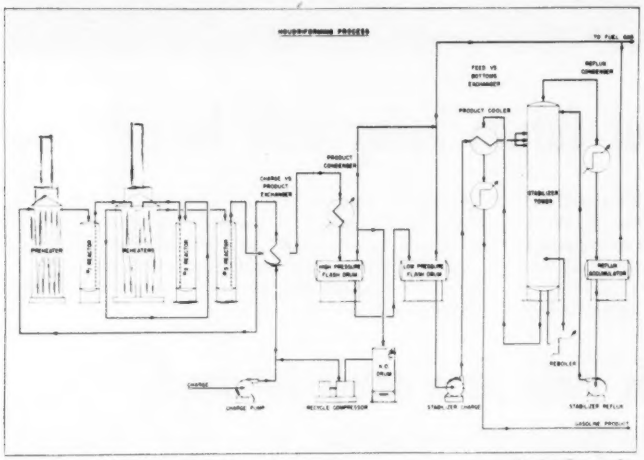
Technibriefs

Gasoline Process

The critical status of high octane gasoline production is indicated in the most recent survey of octane requirement published by the Coordinating Research Council which represents petroleum refiners and the automobile industry. This report shows that the average premium gasoline produced in 1950 satisfied the octane requirements of only 75 per cent of high-requirement cars, while the average regular grade satisfied only 55 per cent of all cars. The Houdry Process Corporation of Philadelphia, Pa., has announced the development of Houdriforming, a reforming process utilizing a unique catalyst which up-grades the low octane components of motor fuel and thereby will greatly assist refiners in meeting the increasing demands for high octane gasoline.

Removal of the restrictions which virgin naphthas impose on the yields of high octane gasoline obtainable from crude oil has long been the dream of refiners. Thermal methods have been used in the past, but such methods yield only relatively low octane number products and therefore cannot meet the current demands for high octane blending stocks. The crux of the problem has been to develop a highly selective catlyst capable of governing the conversion of knock-producing compounds into high octane mixtures for incorporation in motor fuels.

Development of "Houdry Type 3 Catalyst" made possible the Houdriforming process. In this continuous catalytic reforming process, virgin naphthas are passed over the pelleted catalyst arranged in beds within reactor vessels. In the ensuing reactions this dual-function catalyst strips and rearranges the molecular structure of knock-producers—reforming them into high octane compounds. Experimental runs indicate that this process can convert naphthas into gasoline of over 100 octane number with excellent yields. In fact, it is estimated that if all the virgin naphthas were upgraded to high octane levels by Houdriforming instead of by the older thermal reforming method, a saving of 4.5 per cent in crude oil would be effected.



—*Houdry Process Corp.*

Process for improving motor fuel.

Houdriforming also is of interest to producers of natural gasoline—that volatile mixture obtained by condensing the gasoline vapors present in natural gas.

In addition to upgrading low octane gasoline, Houdriforming operations can be adapted alternatively to produce petrochemicals, that fast growing community of chemicals derived from petroleum. Selected naphtha fractions are reformed in Houdriformers to produce large volumes of aromatic chemicals such as benzene, toluene, and xylenes.

An important by-product of all Houdriforming operations is high purity hydrogen. This gas is widely used in petroleum refining as well as in such familiar applications as the production of ammonia for fertilizer and the conversion of vegetable oils into cooking fat.

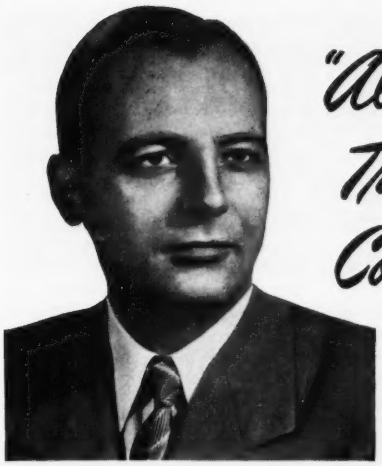
Focusing Searchlights

Growing out of an intensive NBS program to improve Naval aircraft lighting, an automatic focusing device has been developed which improves the reliability of and simplifies aircraft searchlights. In this study, the investigators were concerned with the carbon arc lamp and its focusing problems.

Carbon arc lamps, used because of their high luminance, require elaborate mechanisms to assure satisfactory operation, since the carbon is consumed quickly. These mechanisms must strike the arc when the lamp is turned on, maintain the correct arc length (or current), and keep the carbon tip at the focal point.

Three basic methods have been used to position the tip at the focal point. In the first, which is obviously unsatisfactory for aircraft use, the feed rate of the mechanism is adjusted so that it is the same as the rate of burning of the carbon.

(*Continued on Page* 48)



"Allis-Chalmers Graduate Training Course Helped me Continue my Studies."

says ROBERT D. BAIRD, Ph. D.

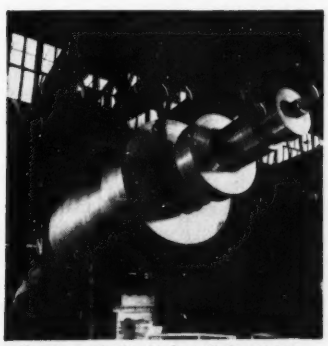
University of Illinois, B. S.—1942 • University of Wisconsin, M. S.—1949
University of Wisconsin, Ph. D.—1951
and now a member of Engineering Calculations Group

"I'VE ALWAYS been interested in the *basic* problems of engineering. But when I got out of school, I needed additional courses to do the things that interested me. More mathematics—more mechanics were required. Since joining Allis-Chalmers, these gaps have been filled."

Variety of Experience

"I became interested in the Allis-Chalmers Graduate Training Course during a plant tour in my Senior year. As I watched men building steam turbines, electric motors, transformers, pumps, rotary kilns, crushers, and many other products, I was impressed by the variety of experiences to be obtained at A-C. It looked to me like a cross-section of heavy industry. When I found that GTC students choose the departments they work in, as well as the type of work, I decided to join Allis-Chalmers.

"As a GTC student, I was given every opportunity to work in many departments. However, the basic problems involving aerodynamics, mechanics and elasticity appealed to me and I chose to work primarily on blowers and steam turbines."



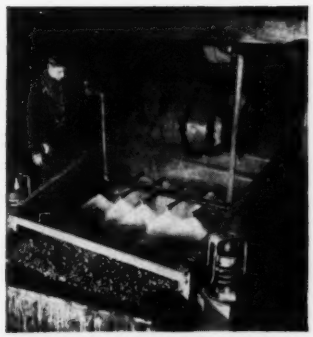
Rough-machined turbine spindle for 120,000-kw steam turbine. Calculating torsional stress and critical speed on shafts like these is part of Baird's job.

Aided by Experts

"Since joining A-C, I have had the opportunity to work with the company's leading consultants, and was encouraged to attend evening courses at the University of Wisconsin, in Milwaukee, which led to a Master's degree.

"In 1949 the company awarded me a graduate fellowship for 12 months' residence study at the University of Wisconsin and I got my Doctor's degree in Mechanics.

"So you see, whether you want to do basic engineering or be a sales engineer, designer, production or research engineer, Allis-Chalmers Graduate Training Course offers a wonderful opportunity."



Vibrating screens by Allis-Chalmers are found throughout the world, wherever coal and ore are mined and rock is quarried.

Facts Graduates Should Know About Allis-Chalmers Graduate Training Course

1. It's well established, having been started in 1904. A large percentage of the management group are graduates of the course.

2. The course offers a maximum of 24 months' training.

3. The graduate engineer may choose the kind of work he wants to do: design, engineering, research, production, sales, erection, service, etc.

4. He may choose the kind of power, processing, or specialized equipment with which he will work, such as: steam or hydraulic turbo-generators, circuit breakers, unit substations, transformers, motors, control, pumps, kilns, coolers, rod and ball mills, crushers, vibrating screens, rectifiers, induction and dielectric heaters, grain mills, sifters, etc.

5. He will have individual attention and guidance in working out his training program.

6. The program has as its objective the right job for the right man. As he gets experience in different training locations he can alter his course of training to match changing interests.

7. For information watch for the Allis-Chalmers representative visiting your campus, or call an Allis-Chalmers district office, or write Graduate Training Section, Allis-Chalmers, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

Technibriefs

(*Continued from Page 46*)

The second method is an optical-electrical system. An image of the positive carbon tip is projected by a small lens onto a sensing element (photocell or bimetallic strip) arranged that as the carbon burns, the image traverses the sensing element. By proper disposition of the element and its associated circuits, the feed of the carbon can be adjusted to restore it to its correct position.

In the third method, known as probe control, a device senses the position of the positive tail flame of the arc. This tail flame is well-defined, fixed in position with respect to the tip, highly ionized and has fairly steep voltage gradients at its boundaries.

The new modification uses the third method, but is designed so that there is no deterioration and no need for maintenance or adjustment. Copper of the highest practicable thermal conductivity is used for the probe. It is a thick disk which enables heat to flow in all three dimensions. Carbon feeds through a hole in the center of the disk; a milled recess in the front of the disk acts as the probe tip. The probe also acts as an obturator (barrier) for shielding the drive mechanism from the heat.

Air Beacon

"Flying lighthouses" are being adopted by commercial airlines in the United States as the latest move in their constant effort to increase aerial safety. These lighthouses-in-the-sky are the airliners themselves, many of which henceforth will carry a high-intensity rotating beacon mounted high atop the vertical fin of the tail assembly. Greater safety in the air is the expected result.

Light source for the beacon is a four and one-half inch diameter lamp of the sealed-beam type, developed especially for this purpose by General Electric. The new lamp will indicate an airplane's presence at greater distances, both day and night, than do present standard lights.

The lamp produces a light beam of 50,000 candlepower, nearly 50 per cent greater than that of an automobile headlamp. At least two air lines now are equipping their fleets, and others are expected to adopt this new safety device.

Leak Detector

A nearly fool-proof method of finding leaks in anything from a football to a complicated coil of pipe or a huge distillation tank has been developed with a gas that once served only as the cold-making agent in refrigerators.

The new test medium is Du Pont Freon-12 fluorinated hydrocarbon; under pressure it is a colorless, virtually non-toxic and odorless liquid, which changes to a gas when released from pressure at room temperatures. Its use as a leak detector stems from its ability to seek out and escape through the finest openings in almost any material. The exact location of such leaks can be found quickly with an electronic device or a gas-burning torch whose flame changes color in contact with the nonflammable Freon.

A more recent development is the electronic leak detector which is responsive to Freon or other gaseous halogenated compounds.

To perform at top efficiency, most telephone toll or long-distance cables are filled with nitrogen or air under pressure and then sealed, thus keeping out moisture and providing an inert atmosphere for the maze of wires within the cable. To locate leaks which cannot be found economically by other means, Freon-12 fluorinated hydrocarbon is pumped into the cable to displace the nitrogen or air. The electronic tester, sensitive to Freon and riding the cable suspension strand like a monorail car, is pulled along the cable. When the Freon detector spots a leak, a signal is transmitted to the ground crew and repairs are made quickly and surely.

One use is in the testing of complicated pipe coils or pressure vessels too large and cumbersome to be filled with compressed air and dunked in a liquid bath where escaping bubbles would indicate leaks. Leaks in smaller vessels sometimes are found by filling the vessel with a liquid or dye which leaves a tell-tale spot of moisture or stain at a leaky point. Freon offers a better, cleaner, safer test in such application — and without the need for auxiliary pressure-producing pumps. Freon fluorinated hydrocarbon provides its own working pressure, approximately 70 pounds per square inch at ordinary temperatures.

Revolving Stop

A new type of revolving stop for a turret lathe, developed by Prof. Erik K. Henriksen of Cornell, was described in the January 5 issue of *American Machinist*. The device can be built in any shop and made to fit any machine.

Professor Henriksen, head of materials processing in the Cornell School of Mechanical Engineering, developed it originally for use on the department's machines. Its features of simplicity and versatility attracted the magazine's attention.

Corrosion Test

A recent laboratory study by the National Bureau of Standards proves for the first time that the rate of weight loss of a piece of steel corroding normally in soil can be measured electrically, without actually weighing the metal. The study gives further evidence that the electrochemical theory of corrosion applies generally to soils. Although the NBS measurements were restricted to the laboratory, the success of the work suggests the possibility of valuable practical applications, such as determination of the corrosion rate of a tank or other underground structure without the need for visual inspection.

When iron or steel is exposed to the soil, local differences in electrical potential develop at the surface of the metal, resulting in the formation of numerous small corrosion cells. This means that electric currents flow through the soil from certain areas (anodes) to areas of less negative potential (cathodes), with accompanying discharge of hydrogen ions at the cathodes and loss of metal from the anodes. By Faraday's law, the rate of weight loss from corrosion is proportional to the current.

The NBS-demonstrated measuring technique is based on a relation established by other investigators, who showed that the current in a

(*Continued on Page 50*)

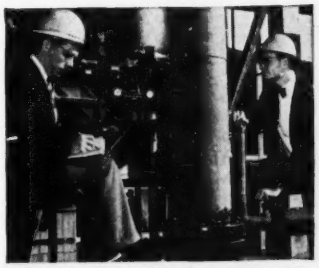
THE DU PONT DIGEST

John Purdom, *B.S. in Ch.E., Ohio State '49, and Kenneth Kehr, North Carolina State '50, discuss diagram of a process for improved recovery of an intermediate for high polymers.*

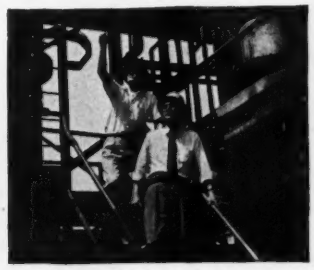
THE ENGINEER'S PLACE IN

Plant Development

Another phase of Du Pont production activities offers challenging work for the technical man



E. H. Ten Eyck, Jr., *B.S. in Ch.E., Syracuse '43, Ph.D. in Ch.E., Brooklyn Polytech '50, and W. H. Stevens, Jr., B.S. in Ch.E., Yale '50, take recordings on a new nylon unit.*



D. S. Warner, *B.S. in M.E., Purdue '47, and G. R. Prescott, B.S. in Met. E., Columbia '49, discuss improvements for stainless steel liners in tubes carrying corrosive materials.*

In most Du Pont manufacturing plants you'll find two groups of engineers working side by side to make operations more efficient—to reduce costs and improve quality. The specialized work of one group, the production supervisors, has been rather fully discussed in the *Digest*.

Equally vital is the work of development men—the men responsible for advising management when operational changes should be made for economic or technical reasons.

Engineers from several fields of training are employed in development activities at Du Pont. It seems to have a special appeal for the man who can take on a big problem, analyze its parts, and come up with a thoughtful, reasoned solution.

Individual development studies may begin in a number of different ways. Often they are sparked by the imagination of the engineer himself, who, of course, must be familiar with production costs, activities of competition, and recent or impending technical improvements.

Studies also may be inspired by suggestions of production supervisors or sales personnel, obsolescence of equipment, advances in competitive products, or the presence of unsatisfactory profit margins.

In a single study, the engineer may draw data from laboratories, semiworks and plant-scale experiments, prepare an estimate of profits and investments and consult with numerous specialists on various phases of the problem, both within the Company and outside.

Having collected data from these many sources and perhaps from an independent study of his own, the plant development engineer must then assemble and evaluate the material and prepare a recommendation that is based on sound engineering judgment.

Whether a product or process improves from the standpoint of competition, profit and efficiency depends, in great degree, on the quality of its plant development work. The development engineer's job is a responsible one at Du Pont, and the work of a good man is soon noticed.

HAVE YOU seen "Chemical Engineers at Du Pont"? New book describes initial opportunities in many fields, tells how experiences are varied to prepare men for administrative and management positions. For copy, write 2521 Nemours Bldg., Wilmington, Delaware.

DU PONT

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

Listen to "Cavalcade of America," Tuesday Nights on NBC—See It Every Other Wednesday on NBC TV

Technibriefs

(*Continued from Page* 48)

corrosion cell can be expressed in terms of the values of applied direct current, from an external source, that will just reduce the cell current to zero.

In establishing the feasibility of the indirect measuring technique, weighed steel specimens, differentially aerated, were exposed at the Bureau to five corrosive soils for approximately two months. The soils ranged in reaction from very acid (pH 2.9) to very alkaline (pH 9.6). Because of the possibility of changes in rates of corrosion during the two-month period, polarization curves were obtained at intervals throughout the exposure period. At the end of this period the specimens were removed from the soils, cleaned, and reweighed. Actual weight losses were compared with weight losses calculated indirectly by Faraday's law. The calculated values of weight loss differed on the average from the actual values by approximately 4 per cent.

Map Production

One of the worst bottlenecks in map production in the field, the color separation of map manuscripts, may be overcome by a plastic scribing process developed by the Army. In preliminary tests the process has been found to reduce by about 50 per cent the amount of time required to extract from a crude map manuscript the detail that is to appear in different colors on the final map.

The process is similar to the glass plate drafting method used by many mapping agencies. In it, however, the glass is replaced by plastic sheeting. It consists of scribing with special tools the reversed blue line image of a map printed on a vinyl plastic sheet which has been coated with a fine pigmented paint. The details are traced on separate sheets according to the color in which they are to appear on the final map. Those to appear in black are traced on one sheet, in brown on another, in blue on a third, etc. From these sheets contact positives on film are made to which certain map symbols and lettering are added. By simple photographic processes lithographic plates used in the printing press are obtained.

Because the plastic scribing process eliminates ink-drafting and reduces color separation to a simplified tracing operation it can be done in one-half the time required by the present ink drafting method. An unskilled man can be trained in one week, while from three to six months of training are necessary for ink drafting.

The line work resulting is comparable to that achieved by the ink method or by glass plate drafting. The latter was also tested for military application but was not considered for field topographic use because of handling difficulties.

I REMEMBER

by

DEXTER S. KIMBALL

Dean Kimball's warm and human autobiography which really is two stories. It is the record of a machine shop apprentice who became Dean of one of the country's great engineering schools and president of the American Society of Mechanical Engineers. It is also a nostalgic and vivid account of America's awakening to the miracles of the machine age.

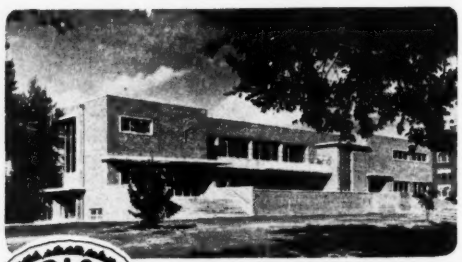
In the clear, animated style of his famous lectures and his lively conversation, Dean Kimball traces the path of his long life—from San Francisco of the eighties to Cornell's campus, from engineering education to engineering practice, and finally, to government service in Washington.

Dexter S. Kimball died on November 1, 1952. One of the last tasks which he completed was checking the proofs of "I Remember." This book offers fascinating reading to all members of the Cornell family.

$4.00

THE CORNELL CAMPUS STORE

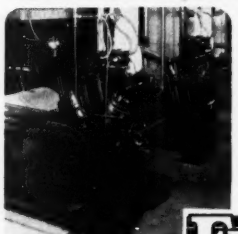
Barnes Hall Ithaca, N. Y.



FRICK

AIR CONDITIONING
Serves New Student Union

Two Frick "ECLIPSE" compressors handle 120 tons of air conditioning in this building at Kansas State Teachers College, Pittsburg, Kansas. Hundreds of students using the rooms are assured the health and comfort of cool, fresh air.



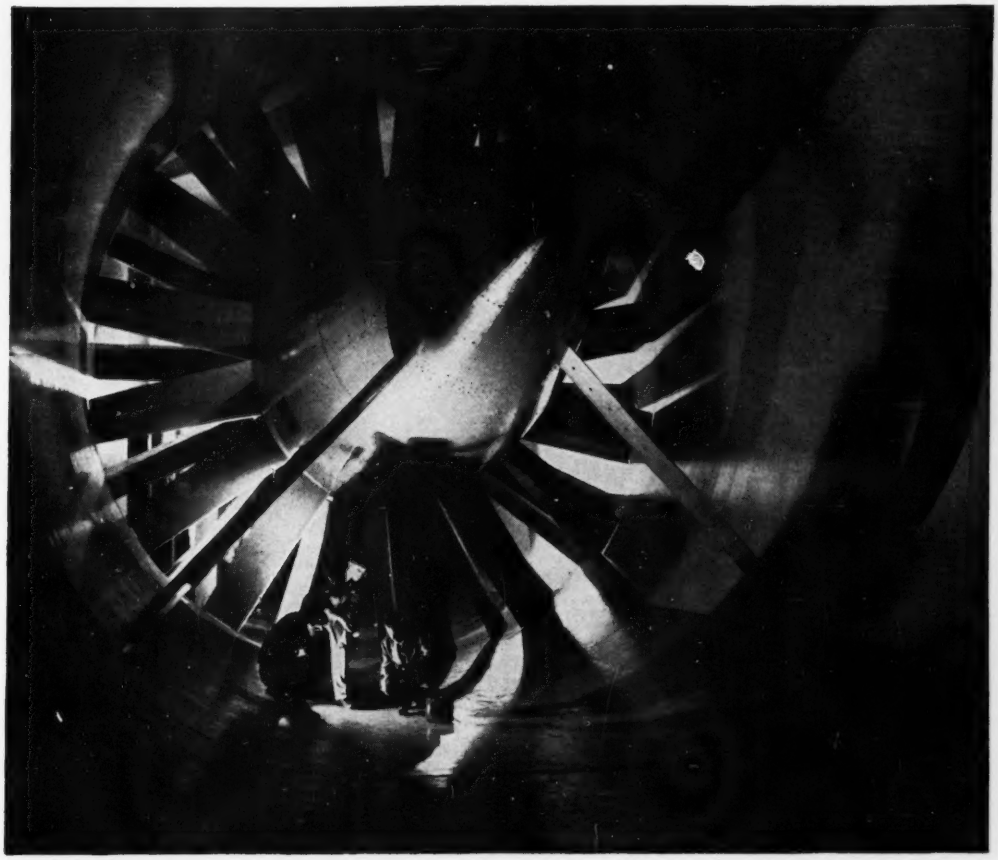
Frick "ECLIPSE" compressors handle low-temperature loads as well as air conditioning.

When air conditioning, refrigeration, ice making or quick-freezing problems arise, see your nearest Frick Branch or Distributor.

The Frick Graduate Training Course in Refrigeration and Air Conditioning, operated over 30 years, offers a career in a growing industry.

FRICK CO.

Also Builders of Power Farming and Sawmill Machinery



Boeing's great new tunnel can help you

Whatever engineering field you enter, you'll get ahead faster if the company you join possesses outstanding research facilities. Boeing's newly redesigned 54,000-hp. wind tunnel – the only privately owned trans-sonic tunnel in the country – is an example of the research advantages that could help you get ahead in this famous company. Other research tools at Boeing include acoustical, hydraulic, pneumatic, mechanical, electronics, vibration and physical research laboratories, among others.

No industry matches aviation in offering young engineers such a wide range of experience, or such breadth of application – from pure research to production design, all going on at once. Boeing is constantly alert to new techniques and materials, and approaches them without limitations. Extensive sub-contracting and major procurement programs – directed and controlled by engineers–afford varied experience and broad contacts with a cross-section of American industry.

Aircraft development is such an integral part of our national life that young graduates can enter it with full expectation of a rewarding, long-term career. Boeing, for instance, is now in its 36th year of operation, and today employs more engineers than at the peak of World War II.

Boeing engineering activity is concentrated at Seattle in the Pacific Northwest, and Wichita in the Midwest. These communities offer fine fishing, hunting, golf, boating and other recreational facilities. Both are fresh modern cities with fine residential and shopping districts, and schools of higher learning where you can study for advanced degrees.

There are openings in ALL branches of engineering (mechanical, civil, electrical, aeronautical, and related fields), for **DESIGN, DEVELOPMENT, PRODUCTION, RESEARCH and TOOLING.** Also for servomechanism and electronics designers and analysts, and physicists and mathematicians with advanced degrees.

For further information, consult your Placement Office, or write:

JOHN C. SANDERS, Staff Engineer—Personnel
Boeing Airplane Company, Seattle 14, Washington

BOEING

How tragically right, Mr. Eastman !

"In the course of almost every fire," said George Eastman, founder of Eastman Kodak, "there is a time when a teacup or a pailful of water will put it out. There is another time, later on, when it takes all the water that can be pumped. There is a well-tried scheme for providing the water to put the fire out when little is required . . . the automatic sprinkler system!"

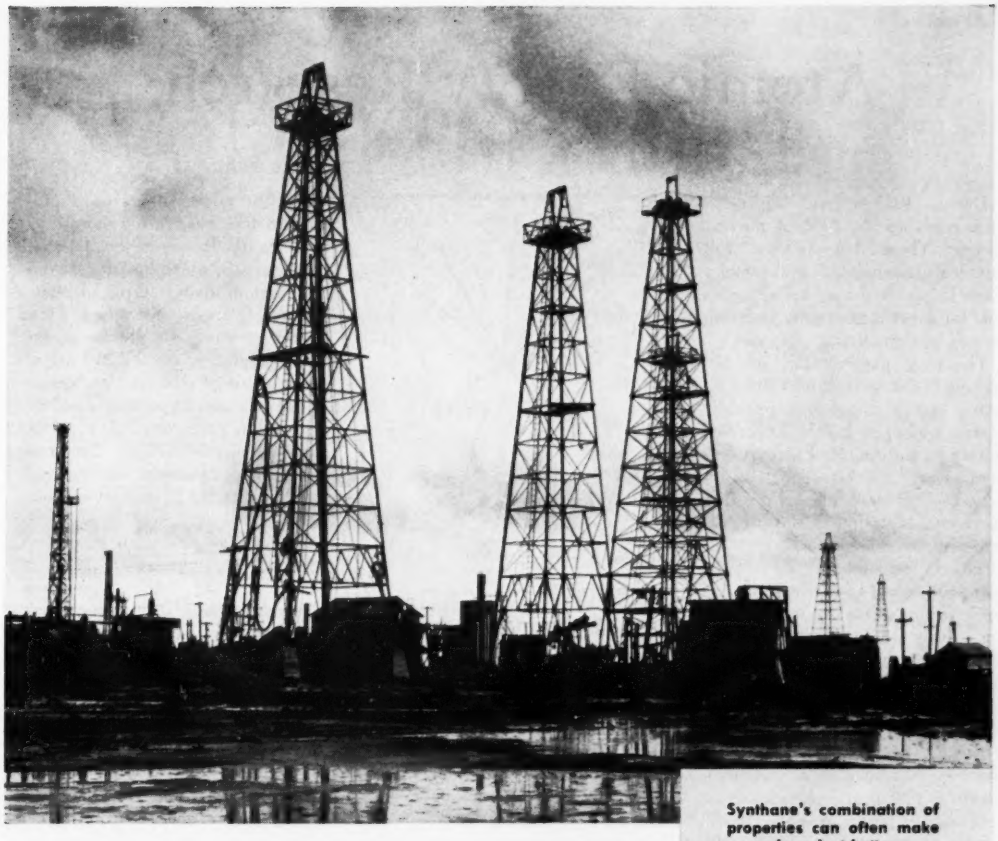
Positive fire protection — whether buildings are "fire-proof" or not — means stopping fire at its start. A Grinnell Automatic Sprinkler System offers such protection — stops fire at its source, wherever and whenever it strikes, night or day, *automatically*. Seventy-four years experience proves this.

People who rely on fire insurance alone are forgetting something. No indemnity check can ever fully compensate for the loss of property, materials, records or profits . . . or the loss of a single life. How much better to prevent needless loss of life and property in plants, warehouses, stores, theaters, clubs, hotels, schools and hospitals — with Grinnell Automatic Sprinkler Systems.

A Grinnell System often pays for itself in a few years through reductions in insurance premiums. For further information, write: Grinnell Company, Inc., Providence, Rhode Island.

GRINNELL
FIRE PROTECTION SYSTEMS

Manufacturing, Engineering and Installation of Automatic Sprinklers Since 1878



From crude to crankcase— with an assist by SYNTHANE

Without oil there'd be no automobiles or airplanes, fewer plastics, soaps, drugs, floor polishes, cosmetics, insecticides.

In one form or another, petroleum and petrochemicals are almost as important to us as the air we breathe. And in one way or another, Synthane plastic laminates are equally important to petroleum production and processing.

• The reason is understandable. Synthane is a dependable material with many uses.

Because it is wear-resistant and tough, yet easy to machine, Synthane is used for components of oil well cementing equipment. Because Synthane is strong and corrosion-resistant, it is excellent for pump valves, piston rings, and compressor plates in tank-farms and refineries. Because it is a good insulator, Synthane in the form of flange insulation provides cathodic protection for pipe lines. Because it is a good moisture-resisting dielectric, light weight Synthane is used in geophysical survey equipment and oil-locating instruments. Wear-and-corrosion resistance make Synthane desirable for flow-line valve-seat inserts.

Because of all these valuable properties, plus many more, Synthane may be a material you can put to profitable use. To find out, get the complete Synthane Catalog. Write to Synthane Corporation, 42 River Road, Oaks, Pennsylvania.

Synthane's combination of properties can often make a good product better.

Strong, light, durable. High tensile, compressive and flexural strengths.

Good insulator; high dielectric strength, low power factor. Low dielectric constant.

Resists moisture, oil, solvents, and corrosive atmospheres.

Synthane—one of industry's unseen essentials

SYNTHANE

LAMINATED PLASTICS

Atomic Energy Research

During 1952 several big steps were made in the field of nuclear energy. These developments will produce quantities of power many times larger than ever before available for experimental and practical, as well as destructive, purposes.

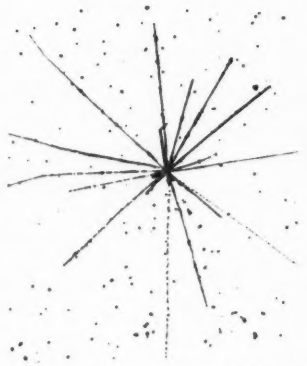
The most spectacular, and disturbing, achievement was the Eniwetok test of the fusion principle of the hydrogen bomb. Described simply by the Atomic Energy Commission as a "thermonuclear reaction," this test was man's first successful imitation of the production of stellar energy.

The hydrogen bomb is an outstanding result of scientific teamwork; still it seems destined to have very little practical use. It is able to produce immense quantities of energy in an instant, but any useful power plant must be capable of continuous power output. The hydrogen fusion reaction, unfortunately, involves such high temperatures that it probably cannot be confined for practical usage. It will remain as a weapon and as an awful monument to scientific knowledge.

The most powerful piece of laboratory equipment in the world was put into operation in 1952. This was the Cosmotron, the Brookhaven National Laboratory's gigantic accelerator of nuclear particles.

Design of the Cosmotron began in 1947 and most of the construction was completed in 1951. On May 20, 1952, the machine speeded up protons to an energy of 1.3 billion volts, approximately three times that achieved by the most powerful cyclotrons, and June 10 exceeded 2 billion volts. Modifications are now being completed which will enable the machine to deliver 2 to 3 billion-volt energies on a routine basis for research in 1953. Study of resultant "nuclear debris" contributes to knowledge of particles and the powerful forces which bind them together in the nucleus of the atom.

As its name indicates, the Cosmotron produces particles of energy comparable to that of cosmic rays. With this controllable source of such rays in hand, physicists are now prepared to perform experiments on such particles under precise laboratory conditions. This will enable physicists to take a long step forward in understanding high-energy reactions. And operation of the machine provides the "know-how" for building future accelerators to duplicate still higher cosmic ray energies, which go up into the tens and even hundreds of billion volts.



Brookhaven National Laboratory

First two-billion-volt particles split atomic nucleus into 17 parts in the Brookhaven Cosmotron.

For reasons still unknown, the fragments called cosmic rays arrive at high speeds from outer space. At altitudes in excess of 20 miles above sea level, before rays are absorbed by the atmosphere, some of nature's most meaningful "nuclear events" take place. Here, in a constant downpour of nuclear debris, protons and other particles smash into nuclei, releasing mesons and other particles. With these events occurring in the laboratory, rather than the stratosphere, much will be learned about the identity, nature, and interrelationships of these building blocks, and the energy which binds them together in the nucleus.

Nuclear power plants on a production line basis are a long way from reality. However, the fact that Westinghouse alone has under construction or design three of these plants of major size gives some definition about the present status of the science of controlled nuclear energy. One of these nuclear power plants is a prototype that could be installed in a submarine. It is a full-size working model of the submarine atomic plant located at the National Reactor Testing Station near Arco, Idaho.

The second plant is know as Mark II, and manufacture has been started on many of the components. The submarine Nautilus, for which the keel was laid by the Electric Boat Company last July, will be the first submarine to receive this revolutionary new type of power plant. In the reactors for Mark I and Mark II, water is both the moderator and the primary coolant fluid. In the Nautilus, nuclear energy will be put to use for large-scale control-power utilization for the first time.

The production of plutonium, for use in atomic bombs, has been stepped up by the introduction of a continuous separation process. At General Electric's plant in Hanford, Washington, plutonium is made from uranium in huge reactors, or "piles," it is separated from the parent uranium by a chemical process, all conducted by remote controls behind thick walls. Formerly an expensive batch process had been used. That is, one batch of material was put through the separation process followed by another, and then another.

The new method, a continuous one, is much less costly. Its features include continuous recycling of chemicals used in the separation and purification steps, increased yield and improved product quality, and recovery for reuse of uranium which has been irradiated in the piles.

Pioneers Wanted

A YOUNG MAN with vision is a priceless part of our future.

This we know at Goodyear Aircraft Corporation, for our record achievements — as America's only producer of both heavier- and lighter-than-air craft and their components — is due in a large measure to the pioneering of young graduate engineers who came to us, casting about for a place where they could best put their talents to work.

They found it at Goodyear Aircraft, a place that offers every engineer an opportunity to specialize in the work of his choice—a place that encourages the forging of new "firsts" and new futures in new fields.

They found a future that is as secure as it is challenging—for Goodyear, as one of the nation's basic industries, will always be doing business come defense, war or peace.

Today Goodyear Aircraft Corporation is offering opportunities in fields ranging from plastics to electronics, from metallurgy to aerodynamics—for young men of vision seeking an assured future.

We are interested in you if you are interested in pioneering new horizons. Submit a brief resumé of your experience and qualifications, or write us for an application blank and further information. Address: Salary Personnel Department, Goodyear Aircraft Corporation, Akron 15, Ohio.

ENGINEERS WANTED

to investigate the opportunities in research, design and development and production of: AIRPLANES AIRSHIPS • HELICOPTERS • GUIDED MISSILES • ELECTRONIC COMPUTERS • AIRCRAFT COMPONENTS GUIDANCE SYSTEMS • TRANSPARENT ENCLOSURES • REINFORCED PLASTICS • RADOMES • BONDED SANDWICH STRUCTURES • WHEELS AND BRAKES • RADAR STRUCTURES and many others.

GOODYEAR—*The Company with COMPLETE Coverage of the Aeronautical Field*

Take Bill's word for it!

William Carpenter is a sales representative for Columbia-Southern, working out of the St. Louis district sales office. His job is an interesting one and a vital one in the fast-growing Columbia-Southern chemical business.

Bill studied engineering with the thought in mind of becoming a salesman. He has some sound reasoning to offer to the graduate. But let's start at the beginning of his story.

Bill entered Carnegie Tech, Pittsburgh, Pa., in 1942 but the war interrupted his college education for two years. He graduated as a chemical engineer in 1948.

He wanted to get into sales rather than production or engineering. He felt then, as he does now, that an engineering background is becoming an increasingly important one for the man who wants to move ahead in the field of selling. He believes that the vast amount of initiative and imagination in specialized sales work is based on a foundation of technical knowledge.

Bill looked around for quite a bit after graduation to find the right spot for his talents. He had many interviews but finally settled on Columbia-Southern. He was impressed with the caliber of people at Columbia-Southern . . . the type with whom he liked to work. He found Columbia-Southern a progressive, rapidly expanding company. He realized that the sound sales training program, supervised by the Technical Service Department, guaranteed complete understanding of his products. The program called for actual plant work in production, engineering, research and shipping—providing him with the thorough background which would be demanded by his customers.

Bill is glad he decided on Columbia-Southern. He now has full responsibility for all accounts assigned to him as sales representative in the Corporation's St. Louis District Sales Office.

Bill has this to say to the graduate: "Look for a company that is growing. Look for a company that will give you the opportunity to do the work you are best suited to do. Look for the organization which offers real opportunity for advancement."

Columbia-Southern has opportunities for graduates in all business and technical fields including engineering, research and development, sales, plant design, mining, construction, maintenance, production, accounting, transportation and related fields.

You are invited to write now for further information to our Pittsburgh address or any of the plants.

William Carpenter of Columbia-Southern, *left*, is shown in a sales interview with W. F. Schierholz, Jr., Vice President and General Manager of St. Louis Solvents & Chemical Division, Fuel Oil Company of St. Louis.

COLUMBIA-SOUTHERN
CHEMICAL CORPORATION
SUBSIDIARY OF PITTSBURGH PLATE GLASS COMPANY
FIFTH AVE. AT BELLEFIELD · PITTSBURGH 13, PA.

PLANTS: BARBERTON, OHIO • BARTLETT, CALIFORNIA • CORPUS CHRISTI, TEXAS • LAKE CHARLES, LOUISIANA • NATRIUM, WEST VIRGINIA • **DISTRICT OFFICES:** BOSTON CHARLOTTE • CHICAGO • CINCINNATI • CLEVELAND • DALLAS HOUSTON • MINNEAPOLIS • NEW ORLEANS • NEW YORK • PHILADELPHIA • PITTSBURGH • ST. LOUIS • SAN FRANCISCO

Out of the grimy scrap pile come

BETTER STEEL PRODUCTS

How Republic Steel Research is Helping Machine Tool Users...and You!

• An oily mess of steel chips under a machine! So much steel scrap? . . . Yes, but scrap that can tell an important story about the machinability of steel.

Republic metallurgists know that. So they take samples of chips cut from various steels. They study them—measure changes in hardness—right down to each tiny grain of steel.

That's just one of the ways in which Republic has learned so much about the intricacies of steel. There are many others—each a part of Republic's continuous program of research to improve its 3-FOLD SERVICE FOR STEEL USERS.

Here it is:

1. Production of the *best-possible* steels and steel products—thousands of them.
2. Recommendation as to which steel or steel product will do a specific job best.
3. Assistance in developing the most efficient and most economical method of processing or fabrication to achieve the desired end result.

This doesn't necessarily mean that Republic works miracles for steel users . . . but it does mean that Republic keeps alert to changing requirements—that Republic is vitally interested in its customers—and that these working policies help to make Republic a good place to work, a good place to stay.

REPUBLIC STEEL CORPORATION
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, New York

REPUBLIC STEEL

NEWS OF THE COLLEGE

Thirteen staff members from the Cornell Department of Physics and the Laboratory of Nuclear Studies presented papers before the American Physical Society at its meetings at Harvard University in the latter part of January.

They were Profs. Bethe, Dyson, McDaniel, Sproull, Woodward, and Drs. Austern, Butler, Littauer, Mitra, Perry, Ross, Salpeter, and Schweber.

Prof. Arthur Kantrowitz of the Graduate School of Aeronautical Engineering gave an invited paper on "Studies of Thermally Ionized Gases Produced by Shock Waves."

Two other persons from the School of Aeronautical Engineering participated in the 21st annual meetings of the Institute of Aeronautical Sciences in New York City. Nelson H. Kemp, graduate student, and W. R. Sears, director of the school, presented a paper on "Aerodynamic Interference between Moving Blade Rows."

Prof. Bijlaard

An explanation of a type of wing buckling that has puzzled airplane engineers for ten years has been offered by Prof. P. P. Bijlaard of the Cornell School of Civil Engineering. The theory is similar to one he developed in 1939 to explain waves in paved roads.

Professor Bijlaard discussed the theory in a paper before the Institute of Aeronautical Sciences at its annual meeting in the Hotel Astor. The work was done for Bell Aircraft Corporation by Professor Bijlaard, a consultant, and George S. Johnston, structures engineer at Bell.

Experiments have shown that the actual strength of airplane wings is as much as 40 percent less than their theoretical strength. The 'stiffeners" (bracket-shaped aluminum uprights in the wing) buckle and the "skin" (outside plate of the wing) develops waves at much lower pressures than would be indicated by conventional theory.

Professor Bijlaard explained that the crucial factor is the rigidity of the flanges, the short horizontal ends of the stiffeners to which the skin is riveted. Previous formulas for estimating load strength have not included this factor.

Because these flanges are relatively too thin, he said, they act as weak springs and allow the skin to distort. His solution is to strengthen the flanges by using angle- or T-sections to which both the stiffener and the skin would be riveted.

The same kind of buckling may occur in macadam highways, due to horizontal compression induced by steam rollers. The hard road surface would correspond to the skin of the airplane wing, the road bed to the flange, and the earth to the stiffener.

Professor Bijlaard also applied the theory to the "multiweb" structure used in jet planes, which have thinner wings. The paper included intricate formulas for estimating load strength, and charts from which required dimensions can be determined with little calculation.

The theory was supported by data from tests made by the National Advisory Committee for Aeronautics and by Bell Aircraft Corporation. The work was directed by Arthur Schnitt, assistant chief structures engineer at Bell.

ASME

The Ithaca area of the American Society of Mechanical Engineers held an inspection trip to the Ithaca Textiles Corporation on January 21.

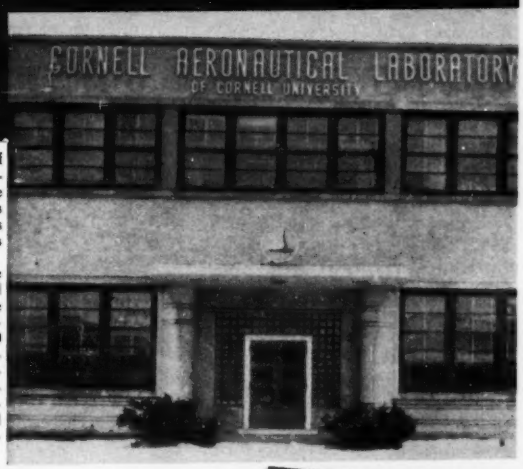
Prof. Vernon Jensen of the School of Industrial and Labor Relations delivered a talk on "Labor Relations and the Engineer" for a meeting of the student division of ASME in February.

Belcher Presents Paper

Prof. Donald J. Belcher of the School of Civil Engineering presented a paper on "Photo-interpretation" during the 19th annual meeting of the American Society of Photogrammetry held in Washington, D.C., in January. Prof. N. A. Christensen, director of the School of Civil Engineering, Prof. Arthur

(*Continued on Page* 60)

to bridge the gap

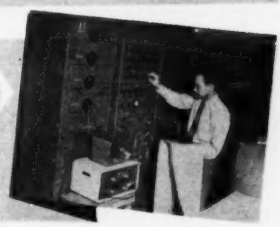


There is a great gap between the fundamental research of a university and the ultimate application by industry. The Cornell Aeronautical Laboratory, Inc., in Buffalo, serves to bridge this gap. As an applied research laboratory, C. A. L. links basic research and manufacturing development as it explores the practical problems essential for solution to assure success of end products.

The applied research and development program of the Laboratory differs from the fundamental research so traditional to universities. As the bridge between raw scientific knowledge and industrial application, the Laboratory operates as a non-profit and self-sustaining corporation, with a staff of about 900 people. Its research activity covers the broad field of aeronautical sciences and is carried on in two buildings by seven technical departments and two divisions. Two of these, the Aerodynamic Research Department and the Aero-Mechanics Department, are described below in the first of a series designed to introduce you to the technical organization of Cornell Aeronautical Laboratory.

William E. Smith, M. Aero. E. '52, is shown by the multi-stage nozzle of C. A. L.'s hypersonic shock tube. He supervises experimental work on this shock tube which will produce flow Mach numbers of about 13.

Leon Bush, B.E.P. '51, at work in the Reeves Analog Computer Room. This analog computer facility is an important tool for the Aero-Mechanics Department's Missile Projects Staffs.



AERODYNAMIC RESEARCH DEPARTMENT

The Aerodynamic Research Department conducts theoretical and experimental research in the fields of fundamental and applied aerodynamics and propulsion. Typical current investigations deal with low-aspect-ratio wings in steady and unsteady flow, subsonic and supersonic wing-body interference, turbulent mixings of supersonic streams, non-stationary compressible flow in ducts, jet engines of the pulsating-flow type, combustion and stability of lames, heat transfer from bodies in a supersonic stream, and hypersonic flow.

The department operates three small wind tunnels: a subsonic two-dimensional 3 x 16 inch tunnel, a transonic 10 square inch tunnel operating from subsonic to low supersonic speeds, and a supersonic 10 square inch tunnel capable of operating up to twice the velocity of sound. A shock tube for creating hypersonic flows of short duration is also employed. Larger scale tests are conducted in cooperation with the Wind Tunnel Department, in its 8½ x 12 foot variable density tunnel. Equipment is available for pressure and flow measurements as well as for many other factors; also for schlieren photography of airflow. Facilities including two air suplies are provided for propulsion tests and for the study of combustion and the microstructure and short-time-interval phenomena of flames under controlled conditions.

AERO-MECHANICS DEPARTMENT

The Aero-Mechanics Department plays a large part in helping C. A. L. maintain its continuing program of research into the possibilities of new types of aircraft and guided missiles. Implicit in this part is the broad responsibility of conducting research pertaining to the composite development of aircraft design and associated guidance or intelligence systems.

In order to carry on constructive research on this multiphased problem of the aircraft as a whole, this department is staffed with men having advanced schooling and experience in such fields as aerodynamics, structures, dynamics, power plants, servomechanisms, thermodynamics and electronics. Their knowledge and experience is applied to the design, analysis and experimental study of advanced supersonic airplanes, helicopters, convertiplanes, and guided missiles to determine the potential of new aircraft configurations and to indicate the problems that require research before these potentials can be realized.

Studies are also made of the problems of stability and control, vibration and flutter, automatic controls, and guidance systems for aircraft. As a supplement to and integrated with the above mentioned research, experimental work is performed by utilizing the department's structural test, electrical and hydraulic laboratories, supplemented by wind tunnel and flight research facilities supplied by other departments.

CORNELL AERONAUTICAL LABORATORY, INC.
BUFFALO, NEW YORK

News of the College

(*Continued from Page 58*)

J. McNair, head of surveying, and Donald Lueder and Dr. Ta Liang, research associates, also attended the meeting.

Visiting Critic

Henry Hebbeln, New York City architect, was a visiting critic in the Cornell College of Architecture from December 8 until January 24.

Mr. Hebbeln received a Bachelor or Architecture degree from Cornell in 1937 and established his own architectural planning and design office in New York in 1946. His work, especially in residential design, has received wide notice.

After graduation, Mr. Hebbeln received a fellowship at the Cranbrook Academy of Art. He then worked with Alvar Aalto in Helsinki, with Gardner Dailey in San Francisco, and with Antonin Raymond in New York City.

He served two years in the Marine Corps and returned to New York to work with William Lescaze.

City Managers

A program to train students for city manager careers will be introduced by Cornell University next September. The two-year graduate course will lead to a master's degree in public administration.

Students will spend more than half the time in business and public administration courses, but will also study such subjects as stream pollution and traffic engineering in the College of Engineering; housing, zoning principles, and regional planning in the College of Architecture; and law of local government in the Law School.

The program will be directed by Prof. Albert M. Hillhouse of the graduate School of Business and Public Administration, which will grant the degree.

All students in this school take basic courses in both business and public administration, with concentration in special fields. The city management concentration is believed unusual in its combination of these courses with other courses in engineering, city planning, and law.

Any college graduate may apply for admission, but preference will be given to those who have studied engineering, economics, government, or business administration.

Cornell's announcement noted that the council-manager system is only 45 years old and is the youngest form of city government. According to the International City Managers Association, the professional organization, more than 1,000 cities in the United States, Canada, and Puerto Rico now use it and more than 250 cities have adopted it since 1948. Kansas City and Cincinnati are the largest cities with long experience with city managers.

The city manager plan emphasizes strong citizen participation through an elected council and mayor, but delegation of day-to-day administration to a full-time professional manager.

[R] LAVA

Manufacturers of Super-Refractories Only

◇

REFRACTORY CRUCIBLES
GRAPHITE CRUCIBLES
HIGH-TEMPERATURE CEMENTS
SPECIAL REFRACTORY BRICK, TILE, SHAPES

◇

From the Following Materials:—

GRAPHITE — SILICON CARBIDE — FUSED ALUMINA — MULLITE
MAGNESIA — ZIRCON

◇

LAVA CRUCIBLE-REFRACTORIES CO.
PITTSBURGH, PA.

You can help plan your career at Detroit Edison

YOUR first job is the foundation for a successful future. You want to prove yourself—to get background and experience for bigger assignments.

Our Company offers you this opportunity.

Detroit Edison is an independent electric company, owned by 55,000 investors and operated by 11,000 employees who serve more than half of Michigan's population.

Here, in every sense, is a forward-looking, growing concern—one which, by 1954, will have doubled its facilities of a decade ago. As one example of its foresightedness, Detroit Edison engineers are working with Dow Chemical Company as one of our nation's five atomic research teams. Intensive studies are under way concerning nuclear heat in relation to thermal electric generating plants.

And so numerous opportunities for advancement exist now and should continue to develop in every department of the Company. Detroit Edison is constantly on the lookout for graduates with initiative and ability who can be trained to fill positions of responsibility in the future.

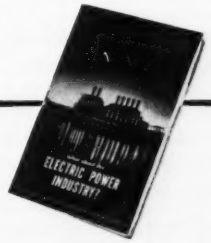
On-the-job training forms an important part of the Detroit Edison picture. For the last 27 years the Company has operated a special College-Graduate-in-Training Program designed to acquaint new employees with the principal operating departments and company points of view. As you visit departments you are not only learning about the Company's business and organization but you also have a chance to select the right kind of work and department you desire. Here you will associate with men of long experience who are nationally recognized for their leadership in the public utility field. Thus, you will lay the groundwork for your advancement and career success.

Many men who now hold high ranking positions in The Detroit Edison Company got their start on training programs like those offered to you today.

DETROIT EDISON PLANS ENGINEERING FUTURES

Don Blodgett set his sights on advancement following graduation from the University of Wisconsin with a BSEE. Five years of Army service delayed his start with Detroit Edison until 1946. Since then his career has been filled with challenge and responsibility. Today finds Don a Senior Engineer directing the work of our high-power laboratory, which proves new equipment design and construction before integration in our Electrical System. Career planning in Don's case still goes on for his engineering future is bright at Detroit Edison.

For the full story of your career opportunities at Detroit Edison, simply call or write for a free copy of this new booklet, "What About the Electric Power Industry?"



The Detroit Edison Company

2000 SECOND AVENUE, DETROIT 26, MICHIGAN

The Ring Test

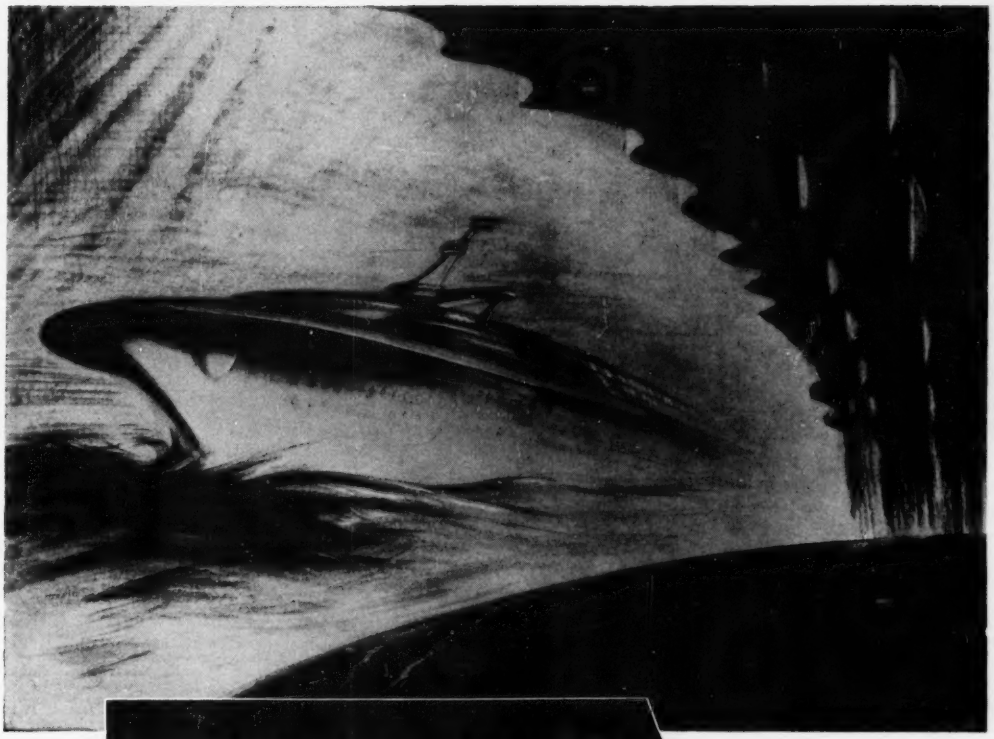
The ring test, shown above, is a scientific method for determining the modulus of rupture of pipe. It is not a required acceptance test but one of the additional tests made by cast iron pipe manufacturers to ensure that the quality of the pipe meets or exceeds standard specifications.

A ring, cut from random pipe, is subjected to progressively increased crushing load until failure occurs. Standard 6-inch cast iron pipe, for example, withstands a crushing weight of more than 14,000 lbs. *per foot*. Such pipe meets severe service requirements with an ample margin of safety.

Scientific progress in the laboratories of our members has resulted in higher attainable standards of quality in the production processes. By metallurgical controls and tests of materials, cast iron pipe is produced today with precise knowledge of the physical characteristics of the iron before it is poured into the mold. Constant control of cupola operation is maintained by metal analysis. Rigid tests of the finished product, both acceptance tests and routine tests, complete the quality control cycle. But with all the remarkable improvements in cast iron pipe production, we do not forget the achievements of the early pipe founders as evidenced by the photograph below of cast iron pipe installed in 1664 to supply the town and fountains of Versailles, France and still in service. Cast iron pipe is the standard material for water and gas mains and is widely used in sewage works construction. Send for booklet, "Facts About Cast Iron Pipe." Address Dept. C., Cast Iron Pipe Research Association, T. F. Wolfe, Engineer, 122 So. Michigan Ave., Chicago 3, Illinois.

Section of 285-year-old cast iron water main still serving the town and fountains of Versailles, France.

CAST IRON PIPE SERVES FOR CENTURIES



BEYOND THE HORIZON....

Most of the current alloys developed for engineering use at elevated temperatures contain Molybdenum.

As stresses and temperatures—such as those used for marine propulsion power plants—increase, it is certain that the alloys which make this possible will rely more and more upon their Molybdenum content.

Climax furnishes authoritative engineering data on Molybdenum applications.

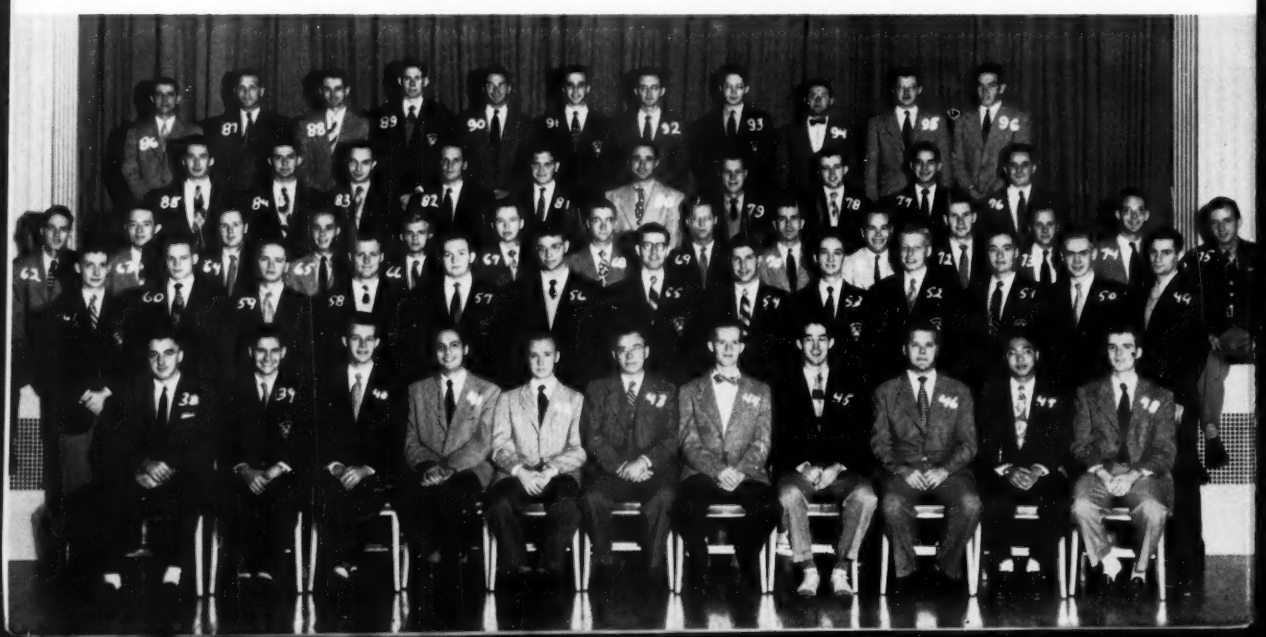
MOLY

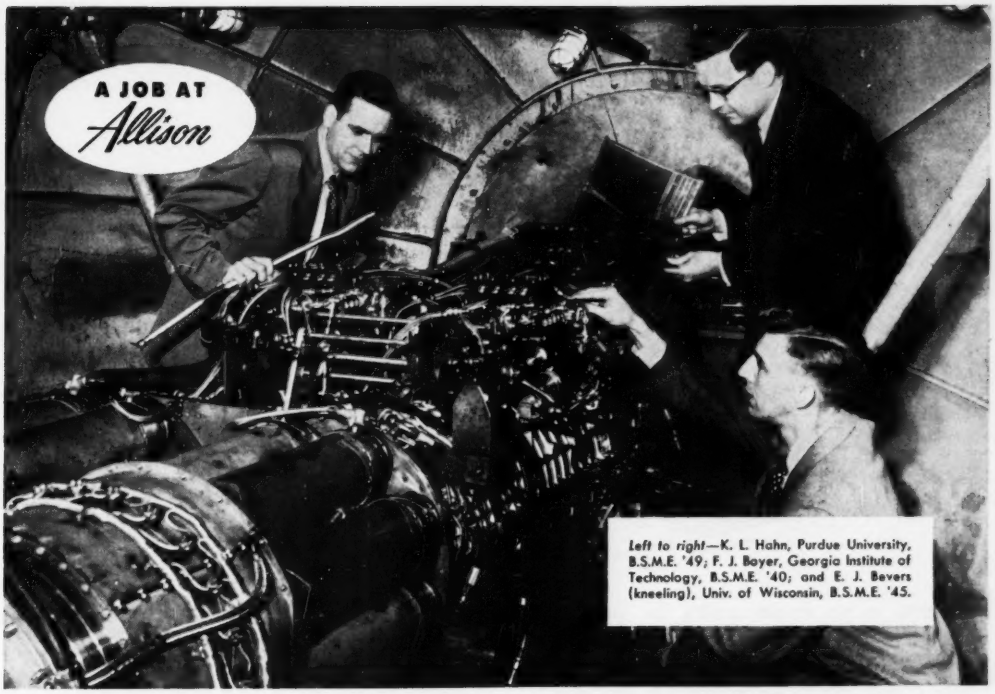
Climax Molybdenum Company
500 Fifth Avenue · New York City 36 · N.Y.

School of Mechanical Engineering

CLASS OF 1953

1. Kaufman, A.
2. Chicurel, R.
3. Berveridge, J. M., Jr.
4. Epstein, H. R.
5. Neuhaus, M. L. (Miss)
6. Loberg, H. J., Director
7. Connors, J. H., Jr.
8. Holbrook, G.
9. Groos, R. T.
10. Parker, M. S.
11. Kennard, P. H.
12. Rosenblum, G.
13. Parmelee, P. O., Jr.
14. Okst, B. A.
15. Ross, D. M.
16. Tupper, F. E.
17. Parker, R. W.
18. Beardsley, D. P.
19. Corpus, A. F.
20. Abizaid, M.
21. Wagner, R. H.
22. Zeiner, E. A.
23. Green, M.
24. Hankins, P. C.
25. Ashton, R. S.
26. Lewis, R. T.
27. Closser, V. A.
28. Dorrance, J. G.
29. Homan, D. F.
30. Iler, N. C.
31. Kennedy, G. M.
32. Smith, R. C.
33. Hopple, J. S.
34. Higgins, J. D., Jr.
35. Werner, J. E.
36. Frainier, R. J.
37. Feiner, A. E.
38. Banks, N. K., Jr.
39. Perris, J. R.
40. Kraska, L. J.
41. Veerman, J. A.
42. Kolflat, R. S.
43. Loberg, H. J., Director
44. O'Neal, D.
45. Hodgson, D. R.
46. Johnston, M. C.
47. Yu, J. S. K.
48. Morrissey, W. G.
49. Galson, A.
50. Lunger, J. W.
51. McIntire, G. H.
52. Heinsohn, W. B.
53. Hilgenhurst, C. G., III
54. Strumer, J. N.
55. Peel, R. E.
56. Metzler, C.
57. Hagenauer, R. G.
58. Follett, D. S.
59. Hillsley, R. H.
60. Barr, F. E.
61. DePalma, S. M.
62. Mackenzie, D. W.
63. Gardiner, A. W.
64. Sedgwick, T.
65. Foulkes, T. S.
66. Bradt, L.
67. Critchfield, R. S.
68. Wilford, J. I.
69. Drake, R. F.
70. Nolin, J. B.
71. Tall, G. W.
72. Bacon, D.
73. Ash, J. M., IV
74. Herman, W. H.
75. Boehringer, J. R.
76. Lehren, R. J.
77. Crane, V. G.
78. Walter, R. B.
79. Roslund, G. R.
80. Klopp, J. W.
81. VerValen, H. C.
82. Howell, F. M.
83. Reisweber, R. C.
84. Wyatt, E. V.
85. Seight, J. C.
86. Faller, J. H.
87. Weis, L. P.
88. Trefts, A. S.
89. Glassey, C. R.
90. Manchester, E.
91. Bush, H. I.
92. Sallack, W. J.
93. Teddlie, E. A.
94. Plant, D. W.
95. Birrell, R. W.
96. Matson, D. C.





Left to right—K. L. Hahn, Purdue University, B.S.M.E. '49; F. J. Boyer, Georgia Institute of Technology, B.S.M.E. '40; and E. J. Bevers (kneeling), Univ. of Wisconsin, B.S.M.E. '45.

● Young Allison aircraft engineers, who not so long ago were in engineering schools as you are now, are playing an important part in development of controls for today's high-powered turbine engines.

Their job is to design an instrument which will relieve the pilot of much of the manual control in engine operation. Once the throttle is set, the control takes over and supplies the right amount of fuel to the engine. The control must compensate for changes in outside temperature, atmospheric pressure and other variables involved in changes in altitude.

This automatic control enables the pilot to concentrate his efforts on the fulfillment of his mission. Meanwhile, his engine is protected against overspeeding, high temperature and other critical factors affecting the life of the powerful turbine engine and the pilot's ability to perform the assigned job.

Floyd Boyer is a Montana boy who came to Allison from Georgia Tech in 1940 as a junior test engineer. By early 1944 he had been advanced to experimental engineer and in 1948 to senior project engineer. His work on engine controls began during World War II when he helped develop the automatic boost control for the two-stage supercharged V1710 reciprocating engines. In 1951 he was made group engineer in charge of turbo-prop control development and now guides the work of twelve other engineers.

E. J. "Gene" Bevers worked with us as a student engineer in the summer of 1944 before graduating in 1945. The Army called him for a two-year hitch but he was back on the job in January, 1947. One of his most interesting assignments while in our test department was as engineering representative during four months of cold weather engine tests in Alaska in the winter of 1951. Today, as Project Engineer in charge of turbo-prop fuel controls, he looks after the application and development engineering on these devices.

Kent Hahn spent his first year with Allison working in several departments and is now a project engineer in the controls development group, working on propeller coordinating controls. He also has had assignments on engine deicing controls, and on controls for the turbo-prop engines in the Allison Turbo-Liner where the commercial advantages of turbo-prop engines are now being demonstrated.

Let's check together on a job for *you* with the world's most experienced manufacturer of turbo-jet and turbo-prop engines.

Allison is looking for young men with degrees in **MECHANICAL ENGINEERING, ELECTRICAL ENGINEERING, AERONAUTICAL ENGINEERING.** ***A lesser number of openings exist for majors in Metallurgy, Electronics, Mathematics and Physics.*** Write now for further information: R. G. Greenwood, Engineering College Contact, Allison Division, General Motors Corporation, Indianapolis 6, Indiana.

Allison **DIVISION GENERAL MOTORS CORPORATION • Indianapolis, Ind.**

Design, development and production—high power TURBINE ENGINES for modern aircraft . . . heavy duty TRANSMISSIONS for Ordnance and Commercial vehicles . . . DIESEL LOCOMOTIVE PARTS . . . PRECISION BEARINGS for aircraft, Diesel locomotives and special application

Build a rewarding career as an S.S.White sales engineer...

Here is an opportunity for qualified engineering graduates to become associated with one of the country's leading manufacturers in a sales engineering job that will bring you in contact with top engineers in all branches of industry.

We are looking for graduate engineers who desire to utilize their engineering training in the sales and application of mechanical products in industry.

As an S.S.White sales engineer you will start at an attractive salary and be trained right on the job to undertake immediate responsibility.

Your opportunities for a lifetime career with S.S.White are unlimited. Promotions are made from within and your accomplishments will be quickly recognized and rewarded.

We will be glad to arrange an interview either at your school or in New York at the S.S.White Industrial Division offices. Write to Department C and include a snapshot of yourself and a brief resume of your education, background and experience.

THE S.S.White INDUSTRIAL DIVISION
DENTAL MFG. CO. Dept. C. 10 East 40th St. NEW YORK 16, N. Y.

HERE'S HELP FOR YOU!

Wrico Lettering Set $6.90

Made by Eugene Dietzgen Co. and containing three Templets—One caps, one lower case, and one of numbers. Sizes 1/8" to 1½"—And your choice of vertical, slant, adv. style and script.

Doric Lettering Set $7.50

One templet—with three cap sizes and one numbers—vertical only.

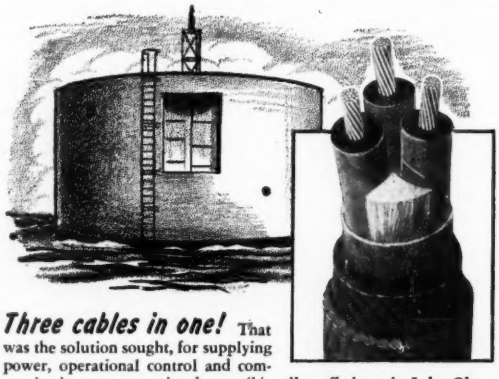
Cross-section paper

All kinds of cross-section paper are in stock at the Triangle for your selection.

You'll enjoy trading at the
TRIANGLE BOOK SHOP

Evan J. Morris, Proprietor

412 College Avenue Shelton Court



Three cables in one! That was the solution sought, for supplying power, operational control and communication to a pumping house 4½ miles off shore in Lake Okeechobee, Florida.

As usual, Okonite engineers were consulted on the problem. Their studies showed that it was possible to combine a three-fold function in one cable. This was accomplished by the use of Okolite high-voltage insulation whose electrical characteristics permitted carrier current to be superimposed on the power conductors.

The result was a single Okonite-insulated cable—steel-armored for the 4½ underwater miles, with a non-metallic sheath for an additional 2½ miles underground—which supplies not only power and operation control, but a communication circuit as well.

• • •

Tough jobs are the true test of electrical cable . . . and installations on such jobs usually turn out to be Okonite.

OKONITE insulated wires and cables

8787

Preparing for specific responsible positions with Trane in sales, research and product design, these graduate engineers are attending a streamlined six-month training course at full pay. This interesting course moves rapidly and adapts the graduate's knowledge of engineering to the position he has chosen.

Trane Offers Engineering Graduates

OUTSTANDING OPPORTUNITIES IN AIR CONDITIONING

Qualified graduate engineers can step quickly into an interesting and prosperous career in the rapidly growing field of air conditioning. The Trane Company, leading manufacturer of air conditioning, heating, ventilating and heat transfer equipment, is seeking graduates for responsible positions in sales, research, product design and production.

Those selected will join the Trane Graduate Training Program in La Crosse at full pay. Each man will receive a specialized course to assure personal success in the position he has chosen.

He will learn how Trane equipment is used in jet aircraft, tanks, submarines, ships, skyscrapers, factories, industries, homes and buildings of all types. He will see how rapidly air conditioning is becoming a necessity . . . how it is destined to become a standard requirement in homes, automobiles, schools, offices . . . everywhere.

Graduates move quickly into responsible, well paid positions. Men who joined the company through this training program include the president and numerous company officers, managers of most Trane sales offices and home office sales divisions.

Trane's record has been one of steady growth and leadership for nearly forty years, during both peace and war. Today, new Trane products are being developed constantly . . . creating new departments and promotions . . . assuring continued growth and business opportunities.

For an outstanding career in one of the fastest growing industries, consider your future in air conditioning with Trane. Write immediately to Milton R. Paulsen, Training Department Manager, for the brochure "Trane Graduate Training Program". Next six-month class starts in July.

WHAT OTHERS SAY ABOUT TRANE

How much can graduates of their training program earn? What about competition? Is Trane strong financially? Does the company offer outstanding opportunities to young men?

For the unbiased answers, read FORTUNE magazine's report on Trane in their August, 1951 issue. Your library should have a copy. A reprint of this report is included in the "Trane Graduate Training Program" brochure which is in your Placement Office.

TRANE

THE TRANE COMPANY • LA CROSSE, WIS.

Eastern Manufacturing Division, Scranton, Pennsylvania
Trane Company of Canada, Ltd., Toronto, Canada
Sales Offices in 85 United States and 14 Canadian Cities

STRESS and STRAIN...

A girl's figure is her fortune providing it draws interest.

* * *

Miriam had not been doing very well in history, although her marks in every other course were high. One day she was called into the professor's office for a conference.

"I'd do anything if I could pass, Professor, anything at all."

"Anything?"

"Yes, anything."

"Are you sure?"

"I just have to pass, Professor, Yes, I'd do anything."

"Hummm, what are you doing Friday night, Miriam?"

"Why, nothing at all, Professor."

"Well, Miriam, I think you might do a little studying."

* * *

"Give me a kiss."
No answer.
"Won't you please give me a kiss?"
Still no answer.
"Please, please, just one."
Still no answer.
"Are you deaf?"
"No. Are you paralyzed?"

* * *

I had sworn to be a bachelor,
She had sworn to be a bride.
I guess you know the answer—
She had nature on her side.

* * *

"How did you get so completely intoxicated?" asked the judge.

"I got in the wrong company, your Honor. You see, there were four of us; I had a fifth of bourbon —and the other three didn't touch the stuff!"

* * *

Salesman: "Is your mother engaged?"

Little boy: "I think she's married."

* * *

Frosh: "Would you please repeat the question?"

Soph: "Beg pardon?"

Jr: "Huh?"

Sr: "Z-Z-Z-z-z-z."

"Pa, tell me how you proposed to Ma," requested the young hopeful.

"Well, Son, as I remember it was like this. We were sitting on the sofa one night at her home, and she leaned over and whispered in my ear.

"I said, 'The devil you are!'

"Next day we were married."

* * *

Dr. Collins was lecturing: "I predict the end of the world in fifty million years."

"How many?" cried a frightened voice from the rear.

"Fifty million years."

"Oh," said the voice with a sigh of relief, "I thought you said fifteen million."

* * *

Coed: "What wonderfully developed arms you have!"

Guard: "Yeah, I'm on the squad. By the way, were you ever on the track team?"

* * *

Engineer: "This new book on health says that bathing alone won't keep you healthy."

Coed: "Well, I don't care what it says, I'm going to keep right on bathing alone."

* * *

Where'd yawl git that Southern accent?

Honey-chile, I'se been drinking outen a Dixie Cup.

Med. Student: "I want to change the death certificate I gave you yesterday."

Professor: "What's wrong?"

Student: "I signed my own name in the space marked cause of death."

* * *

Conrad's party was a roaring success except in one respect—there were no napkins. The store was sold out of paper ones and the linen napkins hadn't come back from the laundry. So Conrad mounted a chair and announced, "Ladies and gentlemen, there are no napkins but at frequent intervals a large wooly dog will pass among you."

* * *

An inmate of a certain insane asylum, feeling that he had recovered enough to be released, appeared before the desk of the superintendent. After he was partially examined he was asked the following question:

Superintendent: "If we discharge you, will you promise to let women and liquor alone?"

Inmate: "Yes, sir."

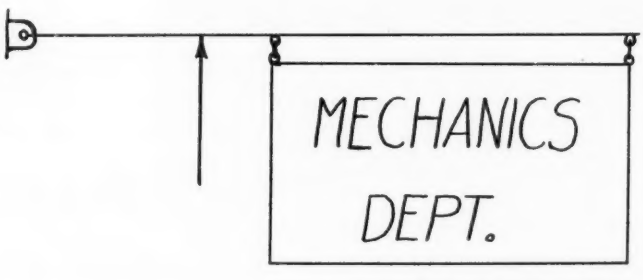
Superintendent (beckoning a guard): "Lock him up; he's still crazy."

* * *

A little worm popped his head up through the warm earth. Suddenly he spied another little worm.

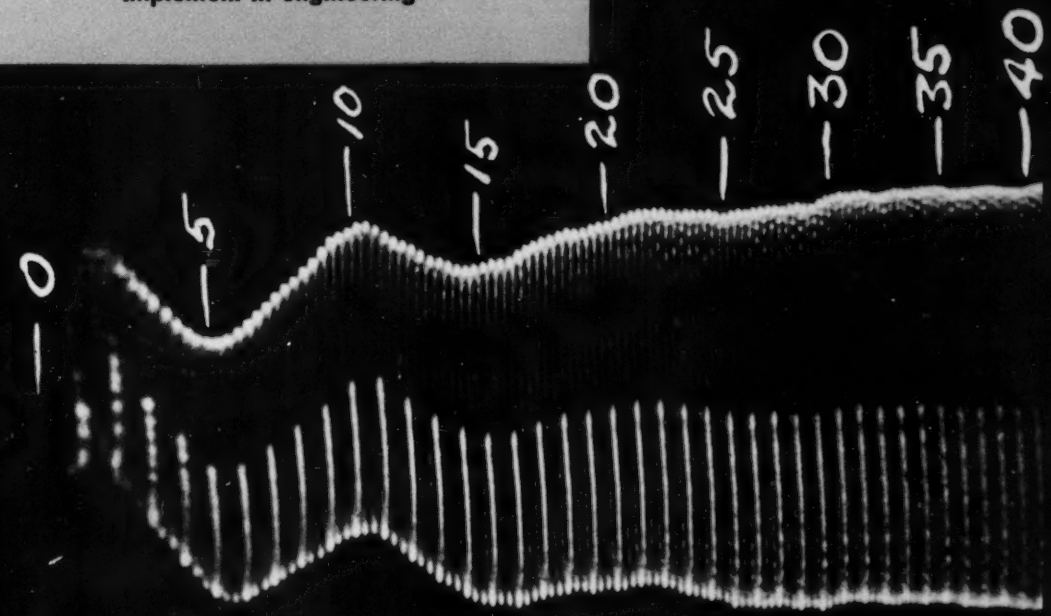
"Gee, you're cute," he said.

"Don't be silly," replied the other little worm, "I'm your other end."



It's fast—it's accurate—it's versatile

—so photography has become an important implement in engineering



This picture is a photographic recording of a cathode ray oscilloscope trace which shows the speed of the reaction of lithium borohydride with an aqueous acid solution.

PHOTO COURTESY OF THE DEPARTMENT OF CHEMISTRY, ILLINOIS INSTITUTE OF TECHNOLOGY, CHICAGO, ILL.

● In the laboratory, in the design department, the production shop and assembly line, in fact all through modern engineering operations, photography is revealing new information, recording facts, aiding new developments, saving time and conserving effort.

Photography can capture the fleeting flick of the cathode ray, trace, and record important engineering information. It can reproduce engineering drawings—microfilm valuable data for easy transportation or space-saving storage. And high speed movies can slow down fast motion so that it can be seen and studied.

In fact, there are so many ways in which photography aids engineering and so many new applications being found, that many well-qualified graduates in the physical sciences and in engineering have been led to find positions with the Eastman Kodak Company.

If you are interested, write to Business and Technical Personnel Department, Eastman Kodak Company, Rochester 4, New York.

FUNCTIONAL PHOTOGRAPHY

—serves industrial, commercial and scientific progress

Kodak
TRADE-MARK

MY QUESTION TO THE G-E STUDENT INFORMATION PANEL:

"How does your business training program prepare a college graduate for a career in General Electric?"

...CHARLES O. BILLINGS, Carnegie Institute of Technology, 1954

The answer to this question, given at a student information meeting held in July, 1952, between G-E personnel and representative college students, is printed below. If you have a question you would like answered, or seek further information about General Electric, mail your request to College Editor, Dept. 123-2, General Electric Company, Schenectady, New York.

R. J. CANNING, *Business Training Course* . . . General Electric's business training program offers the college graduate the opportunity to build a career in the field of accounting, finance, and business management in one of the most diversified companies in the country.

Since its beginning in 1919, more than 3,000 students have entered the program—one of the first training programs in business to be offered by industry.

The program's principal objective is to develop men well qualified in accounting and related business studies, men who can become administrative leaders in the financial and general business activities of the Company.

Selection of men for the program is based on interviews, reviews of students' records, and discussions with placement directors and faculty members. Selection is not limited solely to accounting and business administration majors. A large number of men in the program are liberal arts graduates, engineers, and men with other technical training.

When a man enters the program he is assigned a full-time office position in accounting or other financial work and enrolled in the formal evening education program. This planned classroom work is a most important phase of the program. The material presented is carefully selected and well integrated for the development of an adequate knowledge of accounting and business theory, procedures and policies followed by the Company, acceptable accounting and business practices of the modern economic enterprise, and as a supplement to the practical experience provided by the job assignment.

In general, the program trainee is considered in training for three years during which time advancements are made to more responsible types of accounting work. After completing academic training the trainee's progress and interests are re-examined. If he has demonstrated an aptitude for financial work he is considered for transfer to the staff of traveling auditors or to an accounting and financial supervisory position. From here his advancement opportunities lie in financial administrative positions throughout the Company. Trainees showing an interest and aptitude for work other than financial, such as sales, purchasing, community relations, publicity, etc., are at this time considered for placement in these fields.

Today, graduates of the program hold responsible positions throughout the entire organization. Management positions in the accounting and financial field throughout the Company, such as Comptroller, Treasurer, finance managers, secretaries, and others, are held in large part by graduates of the course. Men who have transferred to other fields after experience in financial work include public relations executives, managers of operating divisions and departments, presidents of affiliated Companies, officials in personnel, employee relations and production divisions, and executives in many other Company activities.

This partial list of positions now filled by former business training men is indicative of the career preparation offered by the business training program, and of the opportunities that exist for qualified men interested in beginning their careers in accounting and financial work.

You can put your confidence in—

GENERAL ELECTRIC

University Microfilms
313 N. First St.,
Ann Arbor, Mich.

Sec. 562, P.L.&R.
U.S. Postage
PAID
Ithaca, N.Y.
Permit No. 76